THURSDAY, OCTOBER 1, 1914.

PONIES, PHEASANTS, AND POULTRY.

(1) *The Shetland Pony.* By Charles and Anne Douglas. With an Appendix on "The Making of the Shetland Pony." By Prof. J. Cossar Ewart. Pp. xi + 176 + plates. (Edinburgh and London: W. Blackwood and Sons, 1913.) Price 10*s.* 6*d.* net.

(2) *Pheasants and Covert Shooting.* By Captain A. Maxwell. Pp. ix + 332 + plates. (London: A. and C. Black, 1913.) Price 7*s.* 6*d.* net.

(3) *Our Domestic Birds.* Elementary Lessons in Aviculture. By John H. Robinson. Pp. x + 317. (Boston and London: Ginn and Co.) Price 6*s.*

(1) IT was a happy thought on Mr. and Mrs. Douglas's part to write the story of the Shetland pony—a survivor of the race of small horses which was established in Britain in very early times. The winsome creature, "small, robust, gay, shaggy, alert, strong of bone, short-eared, large-eyed," may be a composite of Oriental and Scandinavian virtues, but there has been for long a definite unified race, well adapted to the natural conditions and human needs in Shetland. Sheltered by abundant mane and tail and "that waterproof double coat of thick fur and long hair which alone can maintain warmth in wind and rain and mist"; endowed with endurance and "metall past belief"; yet with "docility and sweetness of temper which make it more truly domestic than any other horse," the Shetland pony is congruent with its home. The authors have written of it with pleasure, and their book is naturally therefore pleasant reading. They tell us of the history of the modern Shetland pony, which owes much to the stud established by the Marquis of Londonderry in 1870, and much to a single individual called Jack. They describe the points of the best type, and suggest lines of progress and improvement. There is a valuable chapter on management, evidently based on long experience. The book is finely illustrated with interesting photographs.

We cannot refrain from quoting the delightful closing paragraph of a charming book on a charming subject.

"Yet in the end it is idle to deny that it is not his indisputable economic validity that binds the Sheltie's lovers to him: rather it is himself, his wisdom and his courage, his companionable ways, his gay and willing service. Having taken from him their first falls and first riding lessons, and fought with him their first battles, they look forward to an old age in which he shall draw their bath-chairs; and in the interval of life he provides as a field animal the dual charm of a creature at once wild and tame—wild in his strong instincts, his hardihood, and his independence—domestic in his wisdom and sweet temper, his friendly confidence in mankind, and his subtle powers of ingratiation."

Prof. J. Cossar Ewart has added to the value of the book by furnishing a zoological appendix on "The Making of the Shetland Pony." He comes to the conclusion that—

"Shetland ponies are mainly descended from the 'small and fleet' race yoked to the chariots of the Caledonians at the battle of Mons Graupius. This ancient race, again, was probably to begin with a blend of the slender-limbed, Arab-like ponies of the Swiss lake-dwellers, and of a thick-set race of the elephant-bed type."

As to the small size, he says:

"If Shetland ponies have not sprung from a small wild pigmy race, it may be safely asserted that their small size is mainly due to isolation in small areas where they were forced to shift for themselves under, as a rule, extremely unfavourable conditions."

(2) Captain Aymer Maxwell has written an admirable book on "Pheasants," a welcome companion to his well-known "Partridge." It is marked by competence of information, carefulness of statement, a vigorous, interesting style, and sound judgment on vexed questions. It is embellished by numerous charming coloured pictures by Mr. George Rankine. Most of the chapters are of course practical, dealing with the rearing of birds, the care of coverts, the shooting, the inevitable conflict of interests between fox-hunting and pheasant-preserving, and similar subjects. In connection with covert-shooting, the duck comes in for a chapter. The first three chapters of the book are devoted to questions of natural history—the different kinds of pheasants, their habits, and their history. The Colchican pheasant, now uncommon in Britain, was introduced by persons unknown before 1000 A.D., and remained in undisturbed possession until the end of the eighteenth century, when the ring-necked species was introduced from Southern China. Thereafter came Japanese pheasants, Mongolian pheasants, and more besides; and as most of them interbreed freely, our "common pheasant" is a vigorous mongrel which may combine characters of four or five species. The author has interesting notes on many subjects: the wild traits persisting in reared pheasants, the rate of flight—rather under forty miles an hour, the power of swimming, the cock's dangerous custom of proclaiming where he settles down for the night, the pheasant vocabulary, the courtship, the suppression of scent when

the hen-pheasant is sitting, the miscellaneous diet, the assumption of male plumage by hens, the crossing with capercailzie, blackgame, guinea-fowl, and poultry. We are not forgetting that this is not the first book on the pheasant, but it is written with freshness and first-hand knowledge, and should enjoy a deserved popularity.

(3) We are much behind the times in Britain as regards aviculture, and it is to be hoped that Mr. John H. Robinson's very competent book will serve as a stimulus. It has been computed that the annual production of poultry in the United States approaches the value of a thousand million dollars, and Mr. Robinson shows that there is pleasure as well as profit in the business. We do not think that anyone can read his book without wishing more power to the elbow of those who have been active in recent years in increasing and improving poultry-keeping in this country. It should be noted that Mr. Robinson's book is actually meant for schools, and that he defends this on educational as well as on utilitarian grounds. His enthusiasm is not damped by any thought of the danger, probably in great part a bogey, of tethering school-children too early to the practical problems of life. A second book of a purely technical character is, we understand, being prepared; the object of this one is:

"To tell in plain language the things that everyone ought to know about poultry, pigeons, and cage birds; to teach fundamental facts in such a way that they will be fixed in the mind; to excite interest in the subject where none existed; and to direct enthusiasm along right lines."

Mr. Robinson is not afraid of what his fellow-countrymen sometimes call "hen-fever."

The book deals in a robust practical way with fowls, ducks, geese, turkeys, guinea-fowls, pea-fowls, pheasants, swans, ostriches, pigeons, and canaries and it seems to us to fulfil its purpose. Our only suggestion is that, before a second edition is printed, the author should get some zoological friend to read over the general introduction, which is not without blemish. If aviculture is to be a school-subject, its presentation should be scrupulously accurate. Therefore, some changes should be made in statements such as the following: "Many insects and one species of mammal (the bat) fly." "Man learned melody from the song birds." "These yolks are not germs, but as they grow the germ forms on one side of each yolk, where it appears as a small white spot." These are merely examples of different kinds of statements which admit of improvement. On page 35 it is indicated that the theory of the origin of domestic fowl from the Indian jungle fowl is no longer tenable, but we would refer the author to a well-known American ornithologist, Mr. C. W. Beebe, who wrote in April of this year: "I can find no reason to attribute the ancestry of all varieties of our domestic fowls to other than the red jungle fowl of India, *Gallus Gallus* (Linnæus)." We have not observed any reference to Mendelism in Mr. Robinson's book, but we suppose the omission must be deliberate. If so, one would like to know why.

SILICA AND SILICATES.

La Silice et les Silicates. By Henry Le Chatelier. Pp. 574. (Paris: A. Hermann et Fils, 1914.) Price 15 francs.

SILICA, as is well known, constitutes a large proportion of the earth's crust, and in some form or other plays a very important part in commerce and industry. Silica and silicates are largely used as material for building purposes, for pottery, glass, cement, fluxes, etc. Their full importance is perhaps not brought out in the ordinary text-books; comparatively little is said about them in most books on chemistry and, on the other hand, while in treatises on mineralogy a considerable proportion of the pages are devoted to this large mineral group in their scientific aspect, their practical applications are almost wholly ignored. Prof. Le Chatelier's work is therefore very welcome, especially since it is from the pen of one who has himself done so much to extend our knowledge of the physical properties of the products of these materials.

After a short introduction, in which he epitomises the scope of the book, the author enters into a full description of the characters of the anhydrous and hydrous forms of silica, typified respectively by quartz and chalcedony, and by opal; the rare tridymite and cristobalite are, however, also discussed. Apart from jewelry, quartz is invaluable in saccharimetry and microscopy, and in recent years an extremely important use has been discovered for it in its amorphous form. The excellence of quartz fibres for torsional purposes was pointed out by Boys a quarter of a century ago, and his ingenious method of preparing them has never been improved upon. For vessels likely to be subjected to rapid and considerable changes of temperature amorphous quartz far surpasses glass, and finds extensive use at the present day. Next in a series of five chapters the properties and peculiarities of the principal different varieties of glass are fully discussed.

The various silicates are described in the following series of chapters, but the characters of

most of the species are only summarised briefly, greater space being allotted to those of commercial importance. Considerable attention is, of course, given to china-clay, and this chapter paves the way for an important one on pottery. Incidentally in these chapters many questions of scientific importance are discussed; for instance, solid solutions, mixed crystals, hydrated salts, and the classification of the silicates; Prof. Le Chatelier himself adopts in this book a chemical classification. The admirable work done at the Geophysical Laboratory, Washington, on the artificial production of certain groups of silicates and the determination of their properties, receives adequate treatment. In the concluding chapter the author reviews very briefly the principal rocks and their classification, and the fluxes.

The book is well printed, but, like French books in general, is issued unbound and with uncut leaves. It unfortunately lacks an index.

NEW BOOKS ON CHEMISTRY.

(1) *Modern Steel Analysis.* By J. A. Pickard. Pp. viii + 128. (London: J. and A. Churchill, 1914.) Price 3*s.* 6*d.* net.

(2) *The Synthetic Use of Metals in Organic Chemistry.* By A. J. Hale. Pp. xi + 169. (London: J. and A. Churchill, 1914.) Price 4*s.* 6*d.* net.

(3) *A Third-Year Course of Organic Chemistry.* By Dr. T. P. Hilditch. Pp. xii + 411. (London: Methuen and Co., Ltd., n.d.) Price 6*s.*

(4) *The Viscosity of Liquids.* By Dr. A. E. Dunstan and F. B. Thole. Pp. vii + 91. (London: Longmans, Green and Co., 1914.) Price 3*s.* net.

(5) *Intermetallic Compounds.* By Dr. C. H. Desch. Pp. vi + 116. (London: Longmans, Green and Co., 1914.) Price 3*s.* net.

(6) *De la Pirotechnia* (1540). By V. Biringuccio. A Cura e con Introduzione di A. Mieli. Vol. i. Pp. lxxxv + 198. (Bari: Società Tipografica Editrice Barese, 1914.) Price 3 lire.

(1) THE little volume by J. A. Pickard is one which may be safely recommended to those who are engaged in iron and steel analysis. The introductory chapter might indeed be read with advantage by any analytical chemist whatever his speciality. The sodium bismuthate method for the estimation of manganese is fully described, and the volumetric methods for the estimation of phosphorus, nickel, and chromium, in short, the various processes, so far as the writer can judge, are well up-to-date. It may be observed that the author does not mention the use of porcelain funnels or Gooch crucibles, but recommends pulp filters laid over perforated discs in ordinary funnels. It is impossible to say without experience what advantage the pulp filter has over well-fitting paper discs in a small Buchner funnel, but from the description the former seems the more troublesome arrangement. No reference is made to the moist combustion method described many years ago by Turner in which the carbon was filtered through asbestos and ignited sand contained in a hard glass tube and burnt *in situ*; for Turner's method seems more convenient and accurate than the process described here, involving the transference of the carbon and filter to the combustion tube.

(2) The rapidly increasing use of metals in organic synthesis in recent years has expanded the literature to such dimensions that something in the form of a summary of the methods has become almost imperative, and it is a significant fact that books on the synthetic use of metals have appeared almost simultaneously in both German and English.

The small volume by A. J. Hale includes all the more important methods, which, though not described exhaustively, are thoroughly typical and sufficiently elaborated to render the various processes easily understood. References are also given to the original literature, so that the reader may always supplement his knowledge by turning to the original source. The plan of collecting them at the end of the chapters involves a certain inconvenience, for it necessitates constantly turning over pages, and, as the authors' names are omitted, one is occasionally left in ignorance of rather interesting, if not indispensable, information. The proper place for a reference is surely on the same page as the subject referred to.

(3) The volume on organic chemistry by Dr. Hilditch is the third and last of the series of text-books on this subject which have been prepared for the use of technical institutes. It contains chapters on heterocyclic compounds, the purine group, polypeptides, carbohydrates, terpenes, and the alkaloids.

It would perhaps be more correct to call it a book of reference than a third-year text-book; for it is so closely packed with facts and formulæ that it would tax the powers of an exceptionally good memory to assimilate a fraction of the material in one year. It might also be added that the lettering of the formulæ, especially of the ring compounds, is a severe strain on the eyesight, and might be printed in larger type with great advantage. The book has, however, been carefully and thoughtfully compiled, and should prove useful not only to students of technical institutes

and university colleges, but to others who have an interest in the more intricate branches of organic chemistry.

(4) Among the more valuable of the series of monographs on inorganic and physical chemistry published under the editorship of Prof. Findlay is the volume on the viscosity of liquids, by Dunstan and Thole. The subject is, in a sense, in an elementary stage, but the foundations have been laid, and the results, which have been obtained by the authors who may be looked upon as pioneers in this branch of physical chemistry, promise a valuable aid in elucidating many interesting problems. As the authors state in the preface, the additive effect of a physical property is of little use for the purpose of studying structure; but viscosity, like optical rotatory power, is mainly constitutive, and the difficulty in both cases lies in the interpretation of the numerical values.

The various chapters describe the apparatus, methods of measurement and of calculation, the measurement of the viscosity of pure liquids, of mixed liquids, of electrolytic solutions, colloidal solutions; and the final chapters are devoted to discussing the relation of viscosity to chemical constitution.

It is impossible in the short space allotted to this review to discuss the results; but the volume is a unique contribution to chemical literature, and well worth reading.

(5) The monograph on intermetallic compounds, by Dr. C. H. Desch, has reference to those mixtures of metals which form true compounds, and the methods by which such compounds may be distinguished from simple alloys. That the subject is an intricate one may be judged from the numerous erroneous results which marked the first attempts in this direction, and by the not altogether satisfactory character of the present available data. The first accurate investigations were made by Heycock and Neville in 1897 by means of the freezing-point curve, and these have been followed more recently by the work of Tammann and his pupils. That the subject has been very widely studied may be seen by the long list of references, more than 200 in number, which are given at the end of the volume. The chapters are divided into the following subjects: thermal analysis, microscopic structure, the isolation of intermetallic compounds, their physical properties and chemical nature. The subject is one of the first importance to metallurgists, to whom this excellent and complete summary should make a special appeal.

(6) "De la Pirotechnia," of Biringuccio, of which the present volume is a reprint, appeared in 1540, the year following the death of its author. It has been edited and annotated by A. Mieli, who has also added a valuable introductory and biographical notice. As the name of Vannoccio Biringuccio is little known to English students of chemical history, it may be stated that he was born at Siena in 1480 and died in 1539. His father was an architect, but the son devoted his attention chiefly to metallurgy and mining, and paid several visits to Germany and Austria and other countries in pursuit of his studies. In the disturbed state of Italy at this period, when the Italian towns were constantly in conflict, the fortunes of those who allied themselves with the ruling families were apt to suffer. It is not surprising to find that Biringuccio was twice banished from his native city, when his patrons, the Petrucci, got into hot water, and was also twice recalled.

He was a contemporary of George Bauer (Agricola), whose great work on mining and metallurgy, "De Re Metallica," appeared a little later; for in it a reference is made to Biringuccio, in which Agricola recognises the debt he owes to the work of his predecessor.

Mieli, in his introduction, comparing the work of Agricola with that of Biringuccio, says:

"In Agricola we have the mineralogist and metallurgist, and in certain respects the geologist. Agricola was a man of much erudition, and his work is full of classical references. But Biringuccio was something more. Not only do many portions of the book attest a profound knowledge of chemistry; but they reveal the artist, the craftsman, and the inventor. If Agricola has observed and described, Biringuccio has manufactured and invented new methods and machines, and shown his artistic temperament in the production alike of big and little things. He could cast a cannon as well as a church bell."

OUR BOOKSHELF.

Memorials of Henry Forbes Julian. Written and edited by his wife, Hester Julian. Pp. xix+310. (London: C. Griffin and Co., Ltd., 1914.) Price 6*s*. net.

HENRY FORBES JULIAN, sprung from a Scoto-Irish family, was born at Cork in 1861. During his childhood his family migrated to Bolton, in Lancashire, and there his taste for scientific research was aroused under the teaching of Sir Henry Roscoe at Owens College, Manchester. He began his life as a metallurgist and mining engineer in South Africa, where he did much exploring in the Barotse country, and visited the falls of the Zambezi. He devoted himself to developing the cyanide process of ore reduction, and in collaboration with Mr. E. Smart wrote a standard treatise, "Cyaniding Gold and Silver

Ores." In 1894 he carried out further research on behalf of the Frankfurt Gold und Silber Scheide-Anstalt, and as a consulting metallurgist made repeated voyages to Mexico and other parts of the American continent.

Mr. Julian was a man of wide scientific knowledge, a constant attendant at meetings of the British Association, and other scientific societies, and he had acquired a wide knowledge of literature. A modest, cheerful man, he made hosts of friends, and after his marriage to a daughter of William Pengelly, the well-known geologist and explorer of Kent's Cavern, his home at Torquay became the centre of much scientific and literary activity. On his last voyage to America, on work connected with a patent case, he perished in the wreck of the *Titanic*. Though few details of this final tragedy are available, he certainly displayed the heroism and unselfishness which were the leading characteristics of his life.

In the present memoir compiled by his widow the material is thin, and some of the less important incidents of his life are described with more detail than is necessary. But in the circumstances this is excusable, and the memoir gives a vivid sketch of a life devoted to the cause of science and of an amiable and attractive personality.

A Practical Handbook of the Tropical Diseases of Asia and Africa. By Dr. H. C. Lambart. Pp. xv+324+plates. (London: C. Griffin and Co., Ltd., 1914.) Price 8*s.* 6*d.* net.

WE are told in the preface that "the intention of the author has been to show at a glance, by its alphabetical arrangement, the diagnosis and treatment of the principal tropical diseases; the subjects treated will be found stripped to essentials, and the pages nowhere encumbered with disputed points or theories still *sub judice*, the book thus being arranged for readiest reference."

Such works are seldom to be recommended, because they involve too brief and fragmentary a treatment of subjects which must be dealt with thoroughly if they are to be understood at all; and they are to be recommended still less in medical matters, which are concerned with the life or death of patients. Medical men in the tropics have enough time at their disposal to read at least much fuller text-books than this one, which is apparently designed for the most cursory of readers. Thus, the vastly important clinical theme of abscess of the liver, requiring the utmost care in diagnosis and in medical and surgical treatment, is dealt with in three pages (without mention of Rogers's emetin treatment); and the junior medical man who would trust to this brief note alone might go very seriously wrong.

The author, moreover, can scarcely be commended for the carefulness of his abstracts, or for his grammar, his drawings, or, indeed, his general design, and the accuracy of many of his statements is open to question. The whole work suggests a compilation taken down from previous text-books or from lecture-notes; and the number of similar books on the same subject is already too large.

Leitfaden für Aquarien- und Terrarien-Freunde. By Dr. E. Zernecke. 4, ganzlich neu bearbeitete Auflage von C. Heller und P. Ulmer. Pp. vii+456. (Leipzig: Quelle and Meyer, 1913.) Price 7 marks.

DR. ZERNECKE'S handbook for the amateur management of aquaria and the like is full of valuable information. It pays sufficient attention to amphibia, lizards, snakes, and such small deer, and it touches on the salt-water aquarium, but its full strength is concentrated on the popular fresh-water aquarium. Full directions are given for the installation, aeration, sanitation, and general maintenance of this humanising educational instrument, and a host of water-plants, fishes—both native and exotic—and invertebrates of all kinds are introduced with suitable credentials and attractive portraits.

The Continents and Their People: Africa, a Supplementary Geography By J. F. and A. H. Chamberlain. Pp. vii+210. (New York: The Macmillan Co. London: Macmillan and Co., Ltd., 1914.) Price 3*s.*

THIS book provides an account of Africa and its people which serves to supplement the more technical descriptions of the text-book. Opportunity is taken to give a full treatment of the industries dependent on dates and diamonds. The nomenclature of the States should have been brought up to date, and the account of the causes of the Nile flood should be revised.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Determination of Sex in the Gall-fly, "Neuroterus lenticularis" ("Spathegaster baccarum").

IT is well-known that many Cynipid gall-flies of the genus Neuroterus (Spathegaster) have two generations in the year, one generation of parthenogenetic females and a second generation of males and sexual females. I have previously shown (Proc. Roy. Soc., B lxxxii., 1910, p. 88, and B lxxxiii., 1911, p. 476) that any individual parthenogenetic female has either only male or only female offspring, and that the eggs of the male-producers undergo maturation of a different type from those of the female-producers. I suggested that possibly the determination of male-producing or female-producing individuals depended on the existence of two kinds of spermatozoa. Further experiments extending over the last two years have shown that this suggestion is mistaken, and that the difference between the male-producing and female-producing parthenogenetic females is derived from the sexual female parent. It will take several months at least to complete the cytological investigation of the phenomena which I have in hand, and therefore it may be of interest shortly to record at once the results of the breeding experiments, for they show a type of sex-determination not previously known in the Hymenoptera.

The experiments indicate that any individual sexual female produces either only male-producing or only female-producing parthenogenetic offspring, but not both. Individual fertilised females were allowed to lay on sleeved oak-leaves in May, 1913; the galls produced by each were collected, and sleeved on oak leaves in March of this year. On examining the flies produced, I found that, with a few possible exceptions, the grandchildren of any one sexual female are either all males or all females. I have examined more than 9000 grandchildren of the twelve fertilised females sleeved in May, 1913, and among these there are about 2 per cent. of exceptions to the rule that all the grandchildren of any sexual female are of the same sex. The exceptions, however, do not occur in all the sleeves, but in rather less than half, and I have little doubt that they are due to wild flies having been able to lay eggs in the buds through the muslin of the sleeves. The wild flies were exceptionally abundant this spring, and it is difficult to prevent the buds from pressing against the muslin in such a way that a fly on the outside could not lay in them. I intend to test this possibility next spring, but meanwhile the results obtained make it certain that nearly, if not quite all, the grandchildren of any sexual female are of one sex, and that of the sexual females, those which have male or female grandchildren are about equally numerous.

L. DONCASTER.

Cambridge, September 21.

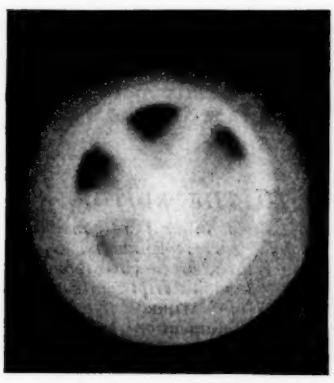

FIG. 1.—Asymmetric. Extreme X-rays (Grazing anti-kathode) 70° from normal in plane at right angles to that of kathode rays.

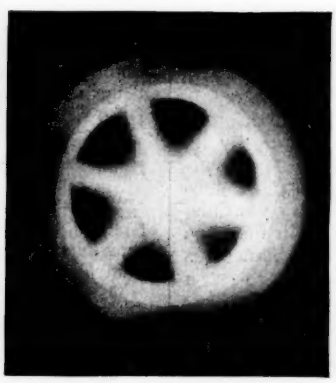

FIG. 2.—Symmetric. Optimum X-rays 15° from true reflection and in plane of kathode rays, *i.e.*, 30° from normal to anti-kathode.

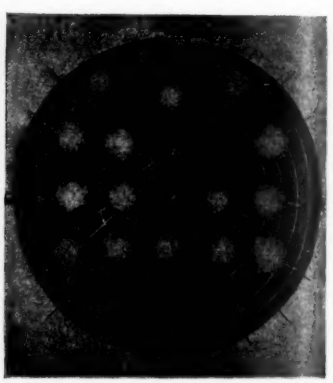

FIG. 3.—Map of hemisphere of X-rays (lead disc) showing radial structure of radiation. Reduced 4 diameters.

Asymmetric "Diffraction" and "Re-Diffraction" of X-Radiation.

FURTHER work upon this subject, briefly described in previous letters (see NATURE, July 16, p. 507), has shown that for any one position of the bulb and object the angle of diffraction is constant. This angle, however, varies with the distance of the object from the source in accordance with a simple inverse sine-law ($\sin\theta \times dcm = 7{\cdot}5$), over the wide range of 8° to 40°, and 50 to 10 cm. This and other well-marked differences from light have been already noticed in our previous papers, and a table of the sine values is given in the present (October) number of the *Röntgen Journal*.

A map of the hemisphere of X-rays, charted by the diffraction images of a lead disc, shows that there is an "optimum," or axis of symmetry, lying in the plane of the kathode rays and 30° from the normal to the anti-kathode (Fig. 3.). Around this axis the effects are increasingly asymmetric. This is shown by the variation of the white band (from a full circle to nearly a semi-circle) within the shadow, and of a dark area between it and the boundary of the image. The positions of maximum intensity have been determined by the photographic and electroscopic methods (see NATURE, August 13, *Röntgen Journal*, July and October, 1914), and are found to be always directed to the optimum axis. The asymmetry has also been established with V-apertures and squares of metal, where the white band appears on one, two, or three (asymmetric), or four sides (symmetry) according to the relative positions (70° to 0°) to the axis of symmetry. The bulb must, of course, be rotated on the spot as centre. In addition to these effects, already described, we have now ascertained that the "diffracted" rays are almost entirely re-diffracted by a second edge. The re-diffraction (as in the case of primary diffraction probably) occurs in two directions, *i.e.* within and without the shadow. Moreover, these effects are again definitely asymmetric when other than optimum rays are used. For instance, a lead disc perforated by apertures symmetrically arranged is shielded by a solid disc of slightly larger dimensions to secure that no rays except those already diffracted by it can reach the second disc. The perforated disc may be placed 0·7 cm. from the plate, and 19 cm. from the anti-kathode, 2·7 cm. separating the discs.

These rays, being normal to the disc, and leaving the anti-kathode at any other than the optimum angle, the images of the perforations will be seen (Figs. 1 and 2) to be increasingly displaced, distorted, and altogether absent in the extreme position. The asymmetry is marked at *opposite points*, and not at the ends of rectangular axes as would be the case were the phenomenon one of *ordinary* polarisation.

A black band *outside the shadow* is naturally only observed when the rays are thus shielded, for otherwise it falls in the area of undiffracted direct radiation.

In these experiments especial care has been taken to keep the milliamperage constant between 1 and 1·5, by means of a variable resistance in the primary.

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GLASS FOR OPTICAL PURPOSES.

THE importance of an adequate supply of optical glass of all the principal types cannot be overestimated. The improvement of the microscope has been and is still retarded for the want of suitable glasses, the construction of large telescopes is limited by the capacity of the glass-maker to supply suitable discs of glass, and the improvements made in the design of small telescopes cannot be extended to larger sizes for the want of suitable glass.

Photographic lenses, binoculars, range-finders, and telescopes of all kinds are dependent for their performance on the good quality, both optically and physically, of the glass used in them. The magnitude of this special branch of the glass-making industry may be gauged from the value of the German exports. In the last year for which figures are available the value of the exports of unworked optical glass exceeded fifty thousand pounds, and large quantities were exported as finished lenses. The characteristic of optical, as distinguished from other glass, is its great homogeneity; veins of material of different composition even in the form of very fine striæ render glass unsuitable for the better class of optical work.

The history of optical glass-making is to a large extent the history of optical progress. Dollond's discovery of the achromatic combination (1757) created a demand for flint glass suitable for optical purposes. At first this demand was met by the selection of the most suitable pieces from the glass manufactured for other purposes, but the demand for larger discs of flint glass led Guinand (1748–1824) to work out new methods of melting flint glass. The essential feature of his method was the continual stirring of the glass to prevent the formation of striæ of different density. Guinand migrated from Switzerland to Bavaria, and in conjunction, first with Utschneider and later with Fraunhofer, improved the process, so that larger blocks of good uniform glass could be manufactured regularly. On Guinand's return to Switzerland, Fraunhofer continued his experiments, and was able subsequently to make good discs of flint glass up to 10 in. in diameter. Meanwhile Guinand had increased the size of discs up to 14 in. diameter, and on his death in 1824 the secret passed to his sons, and through them to Bontemps in France. Bontemps' work was carried on by the French house of Feil, now Parra-Mantois, while Bontemps himself brought the secret process, in 1848, to the glass-works of Messrs. Chance.

For some time the principal advance was in the improvement of the physical properties of the glass, greater uniformity, greater transparency and more durability being aimed at. The calculation of the Petzval portrait lens and its successors led to a large demand for a glass intermediate in type between the ordinary flint and the crown. For this purpose, and for use in the other types of photographic lenses, the series of light flints was worked out. In this series the percentage of lead oxide increases as a higher refractive index is required.

The progress of the microscope makers required the extension of this series of glasses to denser flints, *i.e.* glasses of higher refractive index; at the same time small variations in the constitution of the crown glass were made to give slightly differing optical properties. In this way, by the year 1880 it was possible to make a complete series of glasses with their refractive indices ranging from 1·515 to 1·72. But these glasses had two special characteristics: as the refractive index increased, the dispersion, *i.e.* the difference in the refractive indices for light of two chosen colours, increased more rapidly, so that it was always necessary to use the glass of lower refractive index for the positive lens of an achromatic combination; also the dispersions of two glasses of different refractive index were not proportional throughout the spectrum, so that if a combination of a crown and a flint lens were made to bring the red light proceeding from an object to the same focus as the blue light, the yellow and violet light would not come to the same focus. The consequence was that all images appeared coloured, in spite of the choice of the most suitable curves for the two lenses; this defect is termed "secondary spectrum."

Many attempts had been made to obtain a pair of glasses which would enable the lens-maker to get rid of this secondary spectrum. The experiments of the Rev. W. V. Harcourt (1789–1871), which extended from 1834 to 1871, showed that this problem could be solved; he proved that the effect of substituting boric acid for part of the silica in the glass was to reduce the dispersion of the blue end of the spectrum, and so to make a flint glass which more nearly matched the ordinary crown glass. He was also able to modify the crown glass by using phosphoric acid, but wrongly attributed the result to the presence of titanic acid. Unfortunately these experiments did not lead to practical results, probably because of the expense attaching to experimental meltings on a practical scale.

The next stage in the development of optical glass was the investigation by Schott and Abbe (1881–1886) of the effects of using different materials. With consummate experimental skill, and assisted by generous grants from the Prussian Government, they were able to determine the effects of employing different materials. They were able to confirm Harcourt's results as to the action of boric acid, and correctly to attribute the effects observed by him to phosphoric acid. In addition, they were able to determine the effects of barium both with and without boric acid.

Now the use of boric acid in the ordinary lead glasses always leads to a glass which is more or less liable to spot, but by the use of barium instead of some of the lead this effect is reduced. The boric acid barium glass is, however, of special value, because in this case a high refractive index is associated with a low dispersion. It behaves as a crown glass as regards its dispersion, but

as a flint glass in respect of its refractive index. This property is of special value in the construction of modern anastigmat photographic lenses. These researches of Schott and Abbe were followed by the establishment of the Jena glass-works, where the new types of glass were made on a commercial scale.

The immediate results were—

(1) The manufacture of flint glasses containing boric acid; by the aid of these glasses it was possible to make three-lens objectives free from secondary spectrum, but these glasses are not so permanent as the older types.

(2) The series of phosphate glasses which proved chemically unstable and deteriorated in use.

(3) The boro-silicate crown glasses, which are of somewhat lower refractive index and dispersion than the ordinary crown glass. These are good glasses, and are now extensively used for small objectives and for the prisms used in prism binoculars.

(4) The dense barium crown glasses, containing barium and boric acid. These glasses are used in nearly all anastigmat photographic lenses, but they are difficult to make because such abnormal optical qualities are closely associated with chemical instability.

(5) The most important result was, however, the possibility of obtaining a large range of refractive index and dispersion, so that the designer was able to regard the dispersion and refractive index as more or less independent of each other.

He could design a photographic lens with little regard to the chromatic defects and correct this defect by proper choice of the dispersion of his glass.

These great successes led at first to a concentration of the optical glass industry in Jena, but the success of Chance in improving the quality of the older types of glass, and of Mantois in making the newer types, have somewhat modified this situation, though we are still dependent on Jena for some of the special glasses.

The manufacture of optical glass is not, however, to be lightly undertaken; there would be no great difficulty in finding the composition of glasses of the existing types, though it must be remembered that the mixture used will differ somewhat in composition from the final product. Great difficulties are associated with the purity of the materials and their proper mixing; the pots must be of clay, free from impurities which might colour the glass. The preparation of these pots requires skilled workmen of long experience, and the same may be said of the melting temperatures, the proper period of stirring, the rate of cooling, and the whole annealing process. At the same time, small variations of composition or treatment will affect the optical properties quite considerably. The experimental work associated with the production of special types of glass is expensive and troublesome, since the principal difficulties arise when we endeavour to change from the laboratory to the works scale, and at this stage a single failure may cost fifty pounds.

In view, however, of the importance to our industries and to the army and navy of an adequate supply of optical glass of various types, it is most desirable that our optical glass should be made in this country, and the manufacturers should be encouraged in every way to meet this demand. Success in this direction is, however, most likely to be achieved by scientific experimental work carried out in conjunction with those manufacturers who have already acquired valuable and essential experience in the manufacture of optical glass. S. D. CHALMERS.

THE BRITISH ASSOCIATION IN SOUTH AUSTRALIA.

ADELAIDE, AUGUST 12.

THE Australian meeting of the British Association opened in Adelaide on Saturday, August 8. The main party of overseas members arrived by the Orient mail steamer *Orvieto*, and numbered 150. It included the majority of the "advance party" to Western Australia. A smaller party of fifty members had arrived by the Blue Funnel steamer *Euripides* on the previous evening, and members arriving by other and earlier routes raised the total to approximately 290 overseas members. The local membership roll fell but a single unit short of 600 members, a figure significant of the keen interest taken by the people of South Australia in the advent of the Association.

The Adelaide meeting has been favoured with perfect weather, and only the outbreak of the war cast its gloom over a meeting which otherwise fell nothing short of complete success.

On the afternoon of arrival a special congregation was held by the University of Adelaide, when the following honorary degrees were conferred:—*D.Sc.*—Prof. W. J. Sollas, Prof. A. Penck, Prof. T. W. Edgeworth David, Prof E. W. Brown, Sir Oliver Lodge, Prof. H. Jungersen, Prof. G. W. O. Howe, Dr. C. F. Juritz, and Prof. von Luschan. *M.D.*—Prof. G. Elliot Smith. *M.A.*—Mr. A. D. Hall, Prof. A. P. Coleman. *B.A.*—Sir Charles P. Lucas. *B.Sc.*—Prof. T. Hudson Beare.

In the same evening a reception was given to the overseas members by the State Government, when the visitors were welcomed by his Excellency Sir Henry Galway, Governor of South Australia, and by Mr. Peake, its Premier.

Owing to the short space allotted to the Adelaide Session, sectional meetings were not included in its programme. Presidential addresses were, however, delivered in geography by Sir Charles Lucas and in agriculture by Mr. A. D. Hall.

Two evening discourses were also given in the Adelaide Town Hall by Sir Oliver Lodge, on "The Ether of Space," and by Prof. J. W. Sollas on "Ancient Hunters." Both were listened to with keen appreciation by a large audience.

The major part of the Adelaide programme was occupied by excursions, which were well patronised by the visiting members. On the day of arrival a party of fourteen left Adelaide for an excursion to Broken Hill and the smelting works at Port Pirie. On Monday morning about fifteen members departed, under the leadership of Mr. Walter Howchin, to visit places of geological interest to the south of Adelaide, chief among their objects of investigations being the remarkable evidences of glaciation discovered by Mr. Howchin. On the same day a botanical excursion to the hills in the vicinity of Adelaide, under the leadership of Prof. T. G. B. Osborn, and an anthropological excusion to Milang on the shores of Lake Alexandrina to inspect a party of aborigines there, was made under the guidance of the veteran ethnologist, Prof. E. C. Stirling, who is also the chairman of the local reception committee.

On Tuesday, August 11, a second botanical excursion by motor-car to Mannum on the Murray was made by about a dozen members, and an excursion to Roseworthy Agricultural College by about twenty-five more. Members who did not participate in other excursions were conveyed on Monday by special train to Angaston, a small town fifty-one miles from Adelaide and the centre of a very important viticultural industry, where they were entertained at luncheon by Mr. Charles Angas.

On Tuesday a large number of members were entertained to luncheon by the Adelaide branch of the Commonwealth Club. On Wednesday afternoon, August 12, overseas members departed in three special trains for Melbourne.

DR. H. J. JOHNSTON-LAVIS.

HENRY JAMES LAVIS, who was descended from a Huguenot family settled in Devonshire, and added his mother's name to his own, was born on July 19, 1856, and was unfortunately killed in a motor accident near Bourges, department of Cher, on September 10. After receiving his early education in a private school, Johnston-Lavis commenced his medical education at University College, London, and here came under the influence of Prof. John Morris, from whose teaching he acquired a passion for geological studies. Joining the Geological Society when only nineteen years of age, he had written several geological papers, one of them published in the Journal of the Geological Society, before he was twenty-one. After obtaining his degree of M.R.C.S. in London and holding some minor medical posts in this country, he proceeded in 1880 to Naples, where he established himself as a consulting physician, taking the degree of M.D. in the University of Naples in 1884, and acting as medical officer to Sir William Armstrong's works at Puzzuoli from 1892 to 1897.

It was at Naples that Johnston-Lavis found his most useful sphere of geological labour; besides keeping a diary with photographic records of the action of Vesuvius, he prepared a valuable geological map illustrating the past history of the volcano, with petrological studies of its ejected materials. Incidentally, these studies led to one of his most important memoirs, undertaken in conjunction with Prof. J. W. Gregory, in which the non-organic origin of the one-time famous *Eozoön canadense* was finally demonstrated.

In addition to his studies of Vesuvius, Johnston-Lavis did much useful work in connection with the vulcanology and seismology of the whole South Italian region. Between the years 1892 and 1897 Johnston-Lavis was in the habit of spending his summers at Harrogate, where he acted as a consulting physician. In 1895 he left Naples and, having taken a degree of M.D. at Lyons, established a practice on the Riviera at Beaulieu, while in 1909 he added to this a summer practice at Vittel in the Vosges. His scientific energies never flagged, and more than 160 papers—on volcanoes, earthquakes, mineral waters, and medical subjects— were issued by him, some of them dealing with important theoretical questions. Many geologists and others who visited the Mediterranean area were indebted to Johnston-Lavis for the friendly and valuable aid which he was always ready to afford.

NOTES.

THE death is announced, at seventy-five years of age, of Dr. A. S. Bickmore, formerly curator of the American Museum of Natural History, New York.

IN consequence of the closure of the Anglo-American Exhibition, the visit of the Geologists' Association to the science section, arranged for October 10, will not take place.

DR. HENRY OWEN, treasurer of the National Library of Wales, has been appointed a member of the Royal Commission on Ancient Monuments in Wales, in succession to the late Sir Edward Anwyl.

THE death is announced, by accidental drowning, of Dr. L. C. P. Ritchie, late president and secretary of the Royal Medical Society of Edinburgh, and the author of a number of papers on medical subjects.

ANNOUNCEMENT was made in NATURE of August 20 that, in consequence of the war the publication of the "British Pharmacopœia" had been postponed. The General Medical Council has resolved that advance copies should be made accessible to the public for inspection at the offices of the council in London, Edinburgh, and Dublin on October 1, at 10 a.m., and thereafter from 10 a.m. to 4 p.m. daily. The work will be published at the end of the year.

THE council of the Junior Institution of Engineers has elected the Marquess of Graham as president of the institution for the year 1914–15, in succession to Sir Boverton Redwood, Bart. The Vickers prize, consisting of a gold medal and premium of instruments or books, has been awarded to Mr. James Richardson, for his paper on high-power Diesel engines: their

development for marine service. Mr. Richardson has also been awarded the institution medal for the same paper.

THE Board of Trade has arranged for a Commission consisting of representatives of the Board of Trade, the Timber Trade Federation of the United Kingdom, and the Mining Association of Great Britain, to proceed to Canada and Newfoundland in order to inquire into the possibility of opening up new sources of supplies of mining timber for use in the coal mines of Great Britain. Inquiries on the subject should be addressed to Mr. C. F. Rey, Board of Trade, Queen Anne's Chambers, Westminster.

THE death is reported of Dr. W. L. Dudley, a prominent American chemist. He was born in Kentucky in 1859, and was professor of chemistry and toxicology at Miami Medical College, Ohio, from 1880 to 1886. In the latter year he was appointed to the chair of chemistry in Vanderbilt University, where in 1895 he became dean of the medical department also. He was secretary to the inorganic chemistry section of the St. Louis Congress in 1904, and U.S. Commissioner to the London Congress of Applied Chemistry in 1909. Dr. Dudley had devised an important process for working and electroplating with iridium.

THE war is likely to lead to some readjustment of the trade of the world. The Decimal Association points out in a letter we have received that if British manufacturers are to secure any of the trade which Germany has hitherto carried on with neutral countries, they must be prepared to adopt metric measures of weight, and so on. The association will be glad to help manufacturers and merchants who need assistance, and, if there is a demand, to arrange lectures under the auspices of chambers of commerce during the coming winter. Communications should be addressed to the secretary of the association at Finsbury Court, Finsbury Pavement, London, E.C.

THE death occurred, on September 20, of Mr. William Ascroft, of Cheyne Walk, Chelsea, in his eighty-second year. Mr. Ascroft was responsible for the six beautiful crayon sketches of twilight effects published by the Royal Society in the report on the eruption of Krakatoa in August, 1883. In the November following, the extraordinary twilight glows in the British Isles commanded general attention, and their probable connection with the Krakatoa outburst was pointed out. Mr. Ascroft made his drawings on the bank of the Thames, a little west of London, on the evening of November 26, 1883. They represented the grand general colouring of the western sky from shortly after sunset (3h. 57m. p.m.) to the final dying out of the afterglow at about 5.15 p.m.

IN the September issue of *Man*, Mr. W. N. Beaver discusses the eating of human flesh in the western division of Papua. A long experience of almost every district of British Papua inclines him to believe that while ritual or ceremonial does in many cases form the prime reason for cannibalism, in by far the greater number of cases human flesh is eaten because it is a food and is liked. The practice, however, is not habitual, but sporadic. It is said that snake-eaters are always cannibals. This is not a certain fact in Papua, but it is certainly a coincidence that the majority of snake-eating tribes in the island are also cannibal.

IN *Man* for September Mr. J. P. Johnson describes a collection of pygmy implements from Western Australia in the Perth Museum, and others from Eastern Australia in the Sydney Museum. Like those from South Africa, he regards them as merely diminutive forms or varieties of what French archæologists term the Audi, Chatelperron, and Gravette *pointes* or *couteaux*. These are characteristic of the Aurignaco-Magdalenien specimens of north-western Europe where the crescent is absent, and are prominent in the Capsian specimen of Sicily where the crescent is present. In Australia, however, they do not appear to be associated with scrapers as in Europe and South Africa.

ABOUT 1830 some Chinese and Malay convicts confined in the jail at Mahableshwar, the chief hill station of the Bombay Presidency, are supposed to have introduced the cultivation of the strawberry, which has now become a flourishing industry. The attempt to introduce plants from Saharanpur failed, and the present stock was obtained from Bangalore, where its previous history is unknown. Though they are good and command a ready sale, the berries are capable of much improvement. Dr. W. Burns, economic botanist to the Government of Bombay, who gives a valuable account of the industry in vol. ix., part iii., of the official Agricultural Journal of India, believes that if new stock can be introduced from Europe and America, there is hope of the production of high-class fruit in large quantities in the Yenna Valley.

IT is satisfactory to observe that many field clubs and local natural history societies are devoting attention to the preparation of a flora of the districts in which they operate. The Leicester Literary and Philosophical Society, in its Transactions, vol. xviii., for 1914, recently published, describes the work that is being carried on by their initiative. Many important discoveries, such as *Ceratophyllum submersum*, *Rumex pulcher*, besides cryptogams, have been made. Negotiations with the Uppingham and Rutland Natural History Societies have resulted in an arrangement to include Rutland in the Leicestershire work. So far as the original survey on ecological lines is concerned, the general editor has now defined the main lines of vegetation, and has recorded them on the 6-in. maps. An appeal for assistance from local workers has met with active support.

IN the notice of the recovery of the type specimen of *Pliolophus vulpiceps* in our issue of September 17 it should have been stated that Messrs. Flower and Garson (Cat. Osteol. Mus., R. Coll. Surgeons, part ii., p. 380, 1884) were the first to suggest the identity of Pliolophus with Hyracotherium.

ACCORDING to an article contributed to a Maltese journal of July 23 by Mr. G. Despott, of the Natural History Museum, Malta, the cetacean alluded to in

NATURE of August 13 (p. 620) as having been stranded at Birzebbugia on July 20, is undoubtedly, as suggested in that note, a blackfish (*Globicephala melaena*). The identification is confirmed by photographs forwarded by Mr. Despott, who states that this specimen is the first record of the species in the Mediterranean.

FROM the report for 1913, contained in vol. iv., No. 8, of its journal, we learn that the East Africa and Uganda Natural History Society continues to maintain its record of progress and prosperity, the number of new members being greater than in any previous year. His Excellency Sir H. C. Belfield has been pleased to collect a fund which is to go towards the establishment of a permanent museum, with a curator, and a plot of ground in a central position in Nairobi has been reserved as a site for the proposed new buildings. A feature of the aforesaid number of the society's journal is a coloured plate of the African brown-bellied kingfisher (*Halcyon semicoeruleus*), illustrating an article on this strikingly coloured species by Dr. V. G. L. van Someren.

IN concluding his article on pattern-development in mammals and birds in the September issue of the *American Naturalist*, Dr. G. M. Allen discusses partial albinism in wild birds, and what is termed "centrifugal coloration" in both groups. In the former section it is suggested that the white eyebrow-stripe in the so-called ringed guillemot—now known to be a special phase of the ordinary *Uria troile*—represents an incipient albinism forming a line of demarcation between the dark ear-patches and crown-patches. The author would expect to find this white in young birds, and suggests that, if of a recessive nature, it may eventually be developed in a much larger number of members of the species than is at present the case. As regards centrifugal coloration, this is the development of black pigment at the extremities or points of the body, as exemplified by the black nose and tail-tip not infrequently seen in domesticated cats. The so-called Himalayan rabbits, in which the whole animal is white, with the exception of the black nose, ear-tips, and toes, form another striking example. The paper winds up with a summary of the author's views.

IN connection with the military operations of our Japanese allies in the province of Shantung, the meteorological observations made in Korea, on the opposite shores of the Yellow Sea, for about ten years, are of especial interest. We have recently received the results for the year 1912, and for the lustrum 1906–10. The following extracts from these valuable data, refer to stations in the north-west and south-west of Korea for the lustrum in question. *Chemulpo*: Highest mean monthly maximum temperature (August), 82·8°; lowest mean monthly minimum (February), 19·6°; annual rainfall, 31 in., on ninety-seven days; sunshine, 2726 hours (61 per cent. of possible amount). *Mokpo*: Temperature as above, 86·4° (August); 27·9° (February); rainfall, 38·3 in., on 126 days; approximate sunshine, 2310 hours (52 per cent. of possible amount). The instruments and method of observation are of the same excellent character as those at meteorological stations in Japan, and the tables are carefully prepared by Mr. Y. Wada, director of the observatory at Chemulpo.

WE are glad to see from *Symons's Meteorological Magazine* for September that Dr. Mill is able to resume the editorship after an interval of nearly a year. The size of the magazine has had to be somewhat reduced, owing to the fall in the income of the British Rainfall Organisation through the war. This number contains an interesting article by Mr. H. H. Clayton and Mr. W. M. Hays, entitled "Arguments for Basal and Immediate Crop Estimates," the gist of which is the possibility of substituting for present estimates of crop conditions, based on reports by growers and bureau agents, opinions based on climatic records supplied by a World Meteorological Organisation from daily weather telegrams. The publication by the U.S. Weather Bureau of daily weather charts for the northern hemisphere, and the collection and publication of data from stations to represent the meteorology of the globe, by the efforts of the Solar Commission of the International Meteorological Committee and of the Meteorological Office, are great steps in the above direction. But, as we have before had occasion to point out, the proposals made to the meteorological conferences and meetings to promote the establishment of an international weather bureau have not met with any definite encouragement.

IN the Bulletin of the American Mathematical Society, vol. xx., p. 10 (July), Prof. Edward Kasner discusses certain exceptions to the general rule according to which the ratio of the arc to the chord of a curve tends to the limit unity. In the case of an ordinary singular point the ratio may, of course, be indeterminate, but the author finds that in the case of certain imaginary curves the ratio may have a definite limit different from unity at some particular point or points, even if the curve be analytic in the neighbourhood of the point or points in question. The most typical case is that of a plane curve at a point where the tangent passes through one of the imaginary circular points at infinity. At such a point the ratio of chord to arc becomes $\frac{2}{3}\sqrt{2}$, $\frac{2}{4}\sqrt{3}$, $\frac{2}{5}\sqrt{4}$, and so on according to the order of contact with this particular tangent. The discrepancies are due to the fact that the elements of chord and arc from the point to a neighbouring point both vanish to the first order of small quantities.

IN the Proceedings of the Physical Society for August (vol. xxvi., part 5) Dr. Lees discusses the connection betwen Fourier's series and the method of least squares. This connection was pointed out in Tait's "Natural Philosophy" without proof, and we believe that several other writers have dealt with the question in greater or lesser detail, possibly covering the same ground. The present paper contains a brief proof of the proposition that if it is required to obtain a finite trigonometric series having given values for a corresponding finite number of values of the argument, the series obtained by the Fourier expansion makes the sum of the squares of the errors a minimum.

IT was in 1871 that Lord Rayleigh first proposed a theory to account for the scattering of light by small particles, and in particular to explain the blue sky. Various other papers have followed on the subject by different writers. In the *Bulletin de l'Académie des Sciences de Cracovie*, Dr. Ladislas Natanson, in a paper communicated last January, discusses the problem on lines consistent with the modern electron theories. The author first considers the effect of a vibrating electron in the presence of a train of electromagnetic waves, using Planck's formula. An expression is found for the energy of the scattered wave; this is found to vanish in the direction of propagation and to be a maximum in the equatorial plane. The electric and magnetic energies are not in general equal. When it is sought to deal with a medium containing a large number of such vibrators the problem cannot be solved without making certain assumptions which can only be regarded as a first approximation. With these the author obtains formulæ for the coefficient of transmission of the medium and its dependence on the wave-length.

THE scientific study of the acoustical properties of public buildings is a subject the neglect of which may involve losses of thousands of pounds. The large hall presented to the University College of North Wales by Sir John Prichard-Jones possesses an echo quite equalling the famous one of the baptistery at Pisa, but this feature renders it useless for many purposes for which it would otherwise be in requisition. Mr. F. R. Watson's article on the acoustics of auditoriums in the University of Illinois Bulletin xi., 29 (Bulletin No. 7, Engineering Experiment Station; London: Chapman and Hall, 1914, price 20 cents) is a welcome contribution to this study. The investigation refers primarily to the auditorium of the Illinois University, which has formed the subject of the author's researches since 1908, one year having been spent by him in general study abroad. Mr. Watson discusses Sabine's formulæ for the effect of absorption on reverberation, and arrives at the following general inferences:—Wires have but little effect; air currents due to ventilation may even be worse than useless. In his survey of the building in question he has determined both experimentally and theoretically the paths of the sound waves reflected from the various surfaces, plane and curved, of the building, and the formation of foci; and a remedy has been proposed involving the placing of curtains in positions determined from these observations. The sources of sound employed in these experiments include a ticking watch, an alternating arc current in presence of a concave mirror, and a directed source ingeniously obtained with the aid of a metronome. But the Illinois auditorium with its concave walls and curved roofs is so different from the rectangular Prichard-Jones Hall at Bangor, that an investigation which is sufficient for one building will scarcely be likely to explain, except very partially, the defects of the other.

IT is remarkable that no extended use has ever been made of a phonographic attachment to a telephone for recording spoken messages. The Poulsen telegraphone in which the received currents produced a record by magnetising a steel wire or tape was undoubtedly a scientific success, and perfect speech reproduction could be obtained by its means, but it never made a position for itself as a commercial instrument. The reason for this may have been that the telegraphone had to be electrically connected to the line, and there were possibly some technical or administrative objections to such an addition to a subscriber's instrument. From an article in the *Scientific American* it appears that a new Edison instrument, called the "telescribe," has recently been evolved in which the arrangements are more akin to the Edison wax phonograph. The ordinary telephone receiver of the subscriber's instrument is placed against a very sensitive transmitter, in a local circuit with a battery and another "special" telephone receiver, and the latter is arranged to emit its sound waves against the ordinary sound-recording diaphragm of a phonograph. The instruments of this local circuit must apparently be designed so as to act as a telephone relay and increase the amplitude of the vibrations sufficiently to cut the wax phonograph cylinder. A second receiver on the subscriber's set enables him to listen to the message, and even to contribute his share of the conversation, so that the whole or part of it may be recorded as he desires. This is certainly an ideal arrangement if it gives satisfactory records without impairing the clearness of the articulation by the relaying process.

THE value of the scientific exploration of the agricultural products of India is well illustrated in a paper by Mr. C. Somers Taylor, agricultural chemist to the Government of the province of Behar and Orissa, contributed to vol. ix., part iii., of the official Agricultural Journal of India. Discussing the problem of the varying amount of sugar obtainable from cane juice, he remarks that at one time this was thought to be dependent on the presence of glucose. This theory has now been proved to be unsound by the great Dutch sugar chemist, Geerligs. On the other hand, the same authority—and his conclusions are verified by Indian research—shows that a high percentage of potash is, as a rule, accompanied by a low quotient of purity, a low saccharine content, and a high glucose content when the cane is ripe. The question of potash content is carefully examined by Mr. Somers Taylor in this paper, and he concludes that work on the potash content of cane juice is likely to be of great value in the examination of different varieties of canes, and in consequence the official chemists propose to take up this study more fully in the near future.

THE Institute of Chemistry has issued a "History of the Institute, 1877–1914," compiled, by direction of the council, by Mr. Richard B. Pilcher, the registrar and secretary. The institute had its origin in a meeting held on April 27, 1876, to discuss the necessity for organisation among chemists for the purpose of enhancing their professional status; at this meeting Prof. (later Sir) Frederick Abel presided. A committee was appointed to confer with the Chemical Society with regard to a scheme for establishing an organisation of professional chemists, and ultimately

it was decided to form a new association, and the first officers of the council, with Prof. Frankland as president, were elected in 1877. The membership, which in February, 1878, was 225, had grown in March, 1914, to 1454. Recently new buildings have been erected, duly equipped, and suitable for the purposes of the institute, at a cost of 17,080*l*. Owing to the dispute in the building trades in the early part of this year, these new buildings have not been completed, so that the institute will occupy their present premises at 30 Bloomsbury Square, if necessary until Christmas. A special council meeting was held on June 12 to consider the question of bringing the work of the institute more prominently before the public. Four lectures will be given during the winter months.

OUR ASTRONOMICAL COLUMN.

COMET 1913*f* (DELAVAN).—Delavan's comet is becoming a less favourable object for evening observation owing to the diminution of its declination and its movement westward among the stars. It attains, however, a considerable altitude in the hours just before dawn, and this is the best time for observation. It is situated not far from the star χ Ursæ Majoris, and is approaching α Can. Venaticorum. On clear evenings it is a conspicuous object near the northern horizon and its tail has increased considerably in length. The series of fine nights recently experienced has given opportunities for a considerable amount of observation.

THE RECENT SOLAR ECLIPSE.—The recent eclipse was observed at Paris and Algiers, though at both stations it was only partial. At the Observatory of Paris MM. Bigourdan, Boquet, Chatelu, and Le Morvan made the observations, while M. Gounessiat worked under good conditions at Algiers. The results of these observations have been communicated to the *Comptes rendus*, August 24 and 31. In the case of Paris, M. Bigourdan determined the observed minus calculated times of commencement and end as -23 sec. and -38 sec. respectively. M. Gounessiat, from his observations at Algiers, gives the corrections to his observed times of first and last contact as -25 sec. and -38 sec. respectively.

FRENCH PROVINCIAL OBSERVATORIES IN 1913.—The pamphlet published by the French Minister of Public Instruction and Fine Arts, entitled "Enquêtes et Documents relatifs à d'enseignement supérieur," vol. cix., contains the reports of the French provincial observatories for the year 1913. The observatories dealt with are Algiers, Besançon, Bordeaux, Lyons, Marseilles, Nice, Pic du Midi, and Toulouse. The volume gives a good idea of the various branches of astronomical and meteorological work, which forms the main routine work of the several institutions, besides stating the actual progress made during the past year. It gives further lists of the various staffs, showing that each observatory employs from six to nine scientific members, excluding the Pic du Midi, which is composed of four.

STRONG MAGNETIC FIELDS FOR SOLAR RESEARCH.—MM. Deslandres and Perot present, in the *Comptes rendus* for August 24 (vol clix., No. 8), the second of their series of experiments for the production of most intense magnetic fields. This work is particularly important in its bearing on experiments relative to researches on solar magnetic fields. It is pointed out that the progress of advance in the construction of electromagnets is to be found, not in the saturation of large masses of iron, but in the judicious use of intense electric currents. The authors of the above paper do not therefore advocate the exceedingly ponderous apparatus of Weiss, which weighs about 100 tons, but are directing their attention to comparatively small and light electromagnets. In the present paper they describe somewhat in detail the methods they adopt and the success already achieved speaks well for further advance. With the support of the Princess of Polignac, the electric supply company of Paris, and the electric station of the Bon Marché, they have been able to test their new method of water cooling of the magnetising coils, and have without the use of iron reached a field of 50,000 gauss as measured by its effect on one of the zinc lines. They use thin silver tape instead of wire in their coils, and cool it by a stream of water flowing across instead of along the tape. The difference of potential between two consecutive turns of the tape is kept below 1·4 volts in order to minimise electrolysis. By the use of iron cores the authors hope to be able eventually to reach fields of 150,000 gauss, but their work has been interrupted by the war.

RECENT ECONOMIC ZOOLOGY.

THE University of California has recently issued (Publications in Zoology, vol. xi., No. 14, 1914) a monumental paper on economic ornithology by Mr. H. C. Bryant; although a single species only —the Western Meadow-lark (*Sturnella neglecta*)—is dealt with, the memoir extends to 133 pages, with four plates and many statistical tables. All modes of investigation—field work, experiments with captive birds, examination of stomach contents of adults throughout the year and of nestlings, summaries of the influence of season, locality, age and sex, on the nature of the food—have been brought to bear on the problem. The farmers of California, in reply to circulars sent out by the author, were about equally divided in opinion as to whether this particular bird is harmful or not. Mr. Bryant comes to the conclusion that except for a reprehensible habit of destroying sprouting grain in spring, the Western Meadowlark must be regarded as beneficial from the numbers of harmful insects and weed-seeds that it devours. In addition to the economic interest of this paper, a discussion of the value of "protective" adaptations in insects appeals to the naturalist. A large proportion of the stomachs examined contained hairy caterpillars, ants, wasps, and bees, as well as "cryptically" coloured grasshoppers and weevils. The author admits, however, that the factors of situation and motion at the time of capture might explain why the form and hue of these latter failed to protect them.

The last published part of the Bulletin of Entomological Research (vol. v., part 1, April, 1914) contains an interesting account of the Gold Coast by Dr. J. J. Simpson, who has paid special attention to tsetse-flies and other blood-sucking insects. Mr. W. W. Froggatt has a short but valuable note on sheep-maggot flies in Australia, where species of bluebottle (Calliphora) have, during the last ten years, acquired the habit of "blowing" healthy sheep, as the greenbottle, *Lucilia sericata*, has long done in this country. A minute chalcid parasite does something to keep the flies in check, but they are said to have caused the loss of a million pounds to stockowners last year in New South Wales alone. *Glossina morsitans* in Nyasaland is discussed by Dr. J. O. Shircore, who has traced the fly to four "primary centres," where extermination might be attempted with some chance of success.

Besides the bulletin, the *Review of Applied Entomology* continues to be issued by our Imperial Bureau. The summaries of papers from all parts of the world are of great value to workers, who will doubtless be especially grateful to have the essence of much important Russian literature—otherwise unavailable—brought within their reach.

The twenty-first report of the Danish Biological Station to the Board of Agriculture (Copenhagen, 1914) consists of an important memoir by Dr. C. J. G. Petersen on the animal communities of the sea-bottom and their importance for marine zoogeography. By means of a new "bottom-sampler" the whole animal population of a square metre of the area under investigation can be brought up in one haul, and the results of numerous "valuations" of the sea-bottom at two hundred stations in the North Sea and the Skagerrak are set forth in statistical tables and photographs. the latter reduced to scale, giving a vivid impression of the density of the population and the relative abundance of its various members. By this method of research, Dr. Petersen treats the marine fauna as botanists of the ecological school treat the vegetation of an area, and defines an "Echinocardium-Venus" or a "Brissopsis-Turritella" community as characteristic of certain regions. In the use of this method the author believes that "the animals which are not seasonal and which compose an important part of the whole mass of the community owing to number or weight, will presumably be best suited for characterising the community, and must also be considered as giving a good idea of the outer conditions on which the community is dependent." G. H. C.

FATIGUE STRESSES.

SINCE Wöhler published in 1871 the results of his tests on the behaviour of steel under repeated stresses a great deal of work has been done in this direction. The experiments of Stanton, Eden, Rose, and Cunningham are well known in this country. The subject is a difficult one, and is complicated by the lack of any satisfactory correlation between the tests. Further, experiments on repeated and alternating stresses take a long time to carry out.

In his memorandum to the Manchester Steam Users' Association, Mr. C. E. Stromeyer gives account of some interesting experiments. Mr. Stromeyer has found that all his tests could be harmonised by arranging for successive fatigue fractures on the same test piece, 1 in. or 1½ in. apart. From these tests an empirical relationship was derived, and found to be applicable not only to bending fatigue tests, but also to push-and-pull, and to torsion fatigue tests. The empirical formula is $N = 10^6 C^4 \div (S_n - Fl)^4$, in which $\pm S_n$ is the nominal fatigue stresses to which a sample is subjected, *Fl* is the fatigue limit of the material, C is a constant for the given material, and N is the number of repetitions of the stress S_n, which the material will stand before it fractures. The close agreement of this formula with the test results is demonstrated by diagrams given in the memorandum.

An idea for determining the fatigue properties by means of a single test suggested itself, and proved to be so practical that a new machine has now been constructed for the association with which fatigue tests on the improved lines will shortly be undertaken, both as regards push-and-pull stresses, bending stresses, and torsion or shearing stresses. In principle, the new test consists in determining the stress at which the temperature of the test piece begins to rise in consequence of internal friction. There is practically no internal friction in steel up to a certain limit of stress, and hence no heat would be developed in an alternating or repeated stress test within this limit of stress. The test piece was surrounded with a loose sleeve of thick india-rubber, and circulating water passed along the annular space between the test piece and the rubber; delicate thermometers were used to measure the difference in temperature of the inlet and outlet circulating water. At low stresses no difference in temperature was noticed; when a difference of about 0·01° C. was noticed the fatigue limit was supposed to have been reached, but the fatigue stresses were increased slightly in order to confirm this indication. A considerable difference in temperature was now apparent, but would generally disappear again if the alternating stresses were reduced below the limit. These calorimetrically determined fatigue limits were generally defined very clearly, and may be depended upon as being nearly correct.

Further, the calorimetric fatigue limits agree remarkably well with the fatigue limits *Fl* found by extrapolation of series of tests carried to the point of fracture. Hence it is possible to shorten fatigue testing from several weeks' or months' duration to one or two hours. A single test piece is prepared—duplicates, of course, are desirable—and submitted to gradually increased fatigue stresses until the fatigue limit *Fl* is found calorimetrically; then the stresses are increased until a large quantity of heat is evolved, and the alternations of stress are counted up to fracture. These tests fix both *Fl* and also the coefficient C.

The method seems very promising, and may lead to a simple workshop fatigue test of considerable practical value being adopted in many works where the time occupied in alternating stress tests has hitherto been a barrier.

THE ROYAL SOCIETY OF NAPLES.[1]

THE *Atti* and *Rendiconti* of the Royal Society of Naples for the past year show what valuable work is being done by this Society. The *Atti* (corresponding to our Transactions) contain sixteen memoirs, occupying more than five hundred quarto pages. Papers of less importance are inserted in the *Rendiconti*, which correspond to our Proceedings. Attention should be directed to the very useful and extensive bibliographies which accompany several of the memoirs.

While all the principal sciences are represented, it is to the domain of pure mathematics that the more important work belongs. Mr. G. Gallucci contributes a valuable memoir on configurations (*Atti*, No. 4); Mr. D. Montesano, others on the Cremonian groups of numbers and the bilinear complexes of conics in space (Nos. 7 and 8); Prof. E. Pascal describes integraphs for differential equations (No. 16), and for the graphical solution of integral equations; Mr. G. Andreoli explains a method of determining superior limits to the moduli of the complex roots of a given algebraic equation. In the *Atti* (No. 10) Mr. R. Giacomelli gives a biographical notice of Giuseppe Ballo, a contemporary of Galileo. Among other papers may be mentioned those of E. Guerrieri on the light-curve of Mira Ceti, drawn from numerous observations made during the years 1902–13, of Dr. M. Fidele on the innervation of the reptilian and batrachian heart (*Atti*, No. 2), and of F. Zambonini on Vesuvian mineralogy (No. 12).

The condition of Vesuvius since the eruption of 1906 is the subject of several interesting papers. Prof. G. Mercalli, whose death last March deprived

[1] "Atti della Reale Accademia delle Scienze Fisiche e Matematiche (Società Reale di Napoli)," vol. xv, 1914; Rendiconto, vols. xix, xx, June, 1913—June, 1914.

us of an unwearied investigator of Vesuvian phenomena, contributed two notes in July, 1913, on recent changes in the crater which, in his opinion, point to an early revival of activity after seven years' rest. Mr. O. De Fiore, in a memoir on the period of repose in Vesuvius which began in 1906 (*Atti*, No. 14), remarks that the great outbursts attract most attention, but urges that the intervening periods of repose are also deserving of study, for it is through their investigation that we may be led to foresee a coming revival of activity. He distinguishes three principal, though overlapping, phases in the Vesuvian period of repose, to the first of which—the degradation of recent forms—the present memoir is devoted. Lastly Dr. A. Malladra, of the Vesuvian observatory, describes the solfatara of the Atrio del Cavallo, which separates the modern cone of the volcano from the cliffs of Monte Somma.

THE AUSTRALIAN MEETING OF THE BRITISH ASSOCIATION.

SECTION L.

EDUCATIONAL SCIENCE.

OPENING ADDRESS BY PROF. JOHN PERRY, D.Sc., LL.D., F.R.S., PRESIDENT OF THE SECTION.

I WISH to make some general remarks upon the science of education. As in the chapter which was entitled "The Snakes of Iceland," and which merely consisted of the sentence, "There are no snakes in Iceland," I might finish this Address at once by saying "There is no science of education." There is the art or practice of teaching or pedagogy, just as there used to be the art of engineering. It was only slowly that the subject of Section G, the Science of Engineering, was created; but the subject of Section L, this section, has still to be created. In the creation of a science we first and for long periods have the observation of detached phenomena and disputes about them, because the phenomena seem complex, having no obvious connection with one another; then experiments simplify things, and gradually the science is created by inductive reasoning and research. In education, observation and disputes have occupied much time, and we cannot say that the phenomena have become much simplified by such experiments as have been made. Every man in the street considers that his opinions on education are as good as those of anybody else. I suppose that almost nobody would refuse to make an after-dinner speech on any kind of education, whereas he would not dream of speaking about geometry, or chemistry, or physics, or physiology unless he had studied these subjects. Any ordinary citizen thinks himself fit to be a member of the governing body of a school or college, and the disasters due to this belief are worse than what would occur if we gave to such men the command of ships. The ordinary man, especially the Parliamentary man, who thinks that the members of a committee on some scientific business ought all to be non-scientific men, will jeer at this statement, but it is, nevertheless, fatally true.

It is possible that, even if we had the science, the pedagogues would pay no attention to its principles, just as there are industrial chemists in London whose businesses are dwindling because they pay no attention to the science of chemistry. Pedagogy is in a worse condition than industrial chemistry, because chemical products can be easily tested as good or bad, whereas the pedagogic product is exceedingly difficult to test. The customer is the worst of judges. Those soul-destroying cheap schools described by Mr. Wells used to be very numerous; they are still, many of them, in existence. Every observant person knows of these places, to which small shopkeepers still send their sons, because they are genteel and cheap, and because Latin is taught, and perhaps French. Did any such parent ever object to the result of the schooling? Even when a boy has become a man, neither he nor his father knows whether his defects or merits are due to bad or good schooling. Please read Mr. Wells's book about Mr. Polly. Again, the reforms in pedagogy which, with Dr. Armstrong, I have been clamouring for during the last thirty years, would cause the best-known pedagogues to scrap all their machinery, and so to lose nearly the whole of their invested capital. Even when they are not influenced by the idea of losing money, these men cannot be made to believe in the necessity for reform any more than the Central African worshippers of hideous idols can be converted, for with just as much intensity do they worship the product of our present schools and colleges. The pedagogue is not alone in his false worship; this is the day of small men, common-place men, men manufactured like so many buttons, so that it is almost impossible for a great man to appear; everybody is compelled by custom or by law to go to school, and the school ideal is just as false and mean and material as any false religion ever was. Every clever man who has gone to a public school and to Oxford or Cambridge worships the system which has taken from him his spiritual birthright, his individuality, his initiative, his originality, his common-sense, his power to think for himself—yes, and I may say his belief in himself. He has become too much like a sheep, ready to follow the bell-wether; he is a man who has greatly lost his soul. Average boys leaving a public school all speak in the same way, in the same words, about anything. They are nearly as much alike as things manufactured by the same machine. An expert easily tells from what school a boy has come, because there is nothing left in his mind which is not common to the whole school.

The education given in England to boys until they leave school at twenty, and until they graduate at a university, is almost altogether classical: that is, founded on the language and literature of Greece and Rome. On the day on which I wrote this there was a report of an address in the *Times* which said that this study was the cause "of all imaginative aspirations, of all intellectual interests"; "it enabled men to appreciate not only Homer and Virgil, but equally Dante and Milton, Goethe, and Wordsworth, all the great thoughts of all ages and all lands, and to be awake to the movements of their own day." It said that this study made a man "a better man of business, a better lawyer, a better merchant, a better stockbroker, a less hidebound politician." "Those who would banish Greek or would make it the peculiar property of a select few, did a grave disservice to the whole cause of intellectual and spiritual life." The writer then described his own diligent reading in the train every morning; in the course of a few months he had read the "Iliad," the "Odyssey," the "Aeneid," five books of Livy, and the whole of "Catullus" and "Martial." It seems almost as if he must have all extant classical literature off by heart. He must have enormous satisfaction as he sits in the train looking at the quite common travellers who are reading about the affairs of the nation in English newspapers. I quote the above statements because they are typical. All our classical friends say that sort of thing. But I do not pay much attention to them, because I know that the greatest classical scholars only devote themselves to editing

some Greek text that has been edited over and over again. These men rave about the glory of youth and beauty as preached by the Greeks, but their enthusiasm is not shown in any practical way. We must believe that this enthusiasm exists, because these men tell us themselves that they experience it. But what is a fair man to say when he hears his friends talk of the beauties of Sophocles and Euripides if he knows that these friends never read Shakespeare or Jane Austen, or Goldsmith, or Dickens? I have not referred to the fact that classical scholarship leads to power and wealth in the Church and State, to palaces and baronies, to purple and fine linen. Leaving such things out of account, I have a suspicion that this worship of classics is like one's fondness for the rhymes, often rubbishy rhymes, that associate themselves with our infancy and boyhood, or like Johnson's belief that his wife was amiable and beautiful. It is even possible that the very best scholar is of but little use to the world. It would be easy to show that, since the sixteenth century, the classical pedant has done little but spoil the rich English language of our Bible. We want now a man like Bishop Pecock to delatinise our language.

Let us, however, consider a boy of another class—the boy called clever, say, one in twenty of the whole. At the age of twenty or twenty-one, stale and tired with the reception of ancient learning, of other men's thoughts, he gains a fine scholarship at the university, where he is supposed to be almost a free man, and all the use he can make of his freedom is to go on absorbing ancient learning, keeping his nose to the grindstone as if he were still a schoolboy. Treated as a boy from seventeen to twenty-one, he remains a boy till he is twenty-four, and he cannot help becoming a small-minded, though clever and learned, man, who fails to see that literature is no longer the possession of a small class. Yet if he had left school for the university at sixteen or seventeen, we might hope that university freedom and association with others and with learned men might have made him great, a great poet, a man of cultivated imagination, fit to become a great writer, a great philosopher, a great politician, a ruler of men. One of the curses of intellectual England is due to schoolmasters keeping men at school and treating them as boys to the age of twenty or twenty-one. They take scholarships as stall-fed cattle take prizes at agricultural shows.

Our famous writers had, like Burns, no school education, or else only a short school education. Boys went to the university too early after the Renaissance, and Bacon entered Cambridge at the age of thirteen. Shakespeare, thank God, was only at a grammar school, and is supposed not to have completed even that short course of school work. Even Ben Jonson, who was so proud of his learning and rather scorned Shakespeare for his "small Latin and less Greek," had only a short school education. Phineas Fletcher went to Cambridge at sixteen. Massinger went to Oxford at eighteen. Of the school time of some of our most original writers we have but little information, but that it must have been short we have indirect proof. Beaumont's first play was produced at the age of twenty-one. Waller entered Parliament and wrote his first poem at eighteen. Dryden went to Oxford at seventeen. Milton went to Cambridge at seventeen. Addison went to Oxford at fifteen. The whole of Pope's school education was four-and-a-half years. Swift went to Dublin University at fifteen. Goldsmith, after a most erratic school time, entered Dublin when he was fifteen. Our present school system is to keep a boy with his nose to the classics grindstone from the age of eleven to the age of twenty, and copies the German system. The result is the same in Germany and England. Genius is very common in both countries, but 99 per cent. of it is destroyed by the schools. It is, however, when we come to study the average boy—nineteen in twenty of all boys—that the system looks most devilish. In Germany it is worse than in England. There even the average boy submits, and plods hard all the time, because there is a great reward for him—a diminution in his time of military service. Well, the result for the average German boy is that he becomes stupefied, dull, and loses all initiative. The average English boy gets much less of these evil effects, because he neglects his schoolroom work and keeps his mind active and his soul alive by means of football and cricket. It is from this great characteristic, that knowledge and wisdom come from doing, and not from abstract reasoning, that the British race rules the world. We learn all that induces common-sense from observation and experiment. I often used to observe that a boy whose face was attractive because of its brightness and intelligence in the cricket field, seemed when he entered my classroom as if an isolating veil of unintelligence suddenly covered his face. He had settled for life that he could not understand the classroom work, and he refused to make any more efforts. Even the clever boy's soul is to some extent protected by his sports, so that in every way less harm is done in England than in Germany. Still, the system produces, even from clever boys, only clever, dull men, fit to be barnacles in the public services. The system may be said to give a good training for lawyers—the necessary clever kind of lawyer of the Law Courts and Chambers who is mute in the House of Commons.[1] But it destroys the higher qualities of men and makes them narrow. It ought to be remembered that Lord Somers was the only great lawyer who was also a great man. Poor boys cannot get this training unless they are so unlucky as to get scholarships, or are induced to attend university extension lectures; and it results that nearly all our best writers, writers with imagination and originality and initiative and individuality, have been boys of the common people. Although poor boys are most frightfully handicapped for the race to distinction, I do not think that the poor child is much handicapped by mere heredity, for he is naturally nearly equal to a boy of the highest lineage. Natural selection up to the time of the first great civilisations, when there were comfortable houses and palaces—say, 100,000 years ago—together with the effects since then of revolutions and wars of conquest, involving slavery of the conquered, have created a wonderful equality among the individuals of mixable races.

For the average boy at a public school the school work is a terrible uphill grind all the time; a soul-destroying, stupefying business, so stupefying that he makes no complaint, he merely suffers. He feels that he is a failure, learning nothing that can be of spiritual or material value to him in his future life. Of course, he can pass examinations; anybody can be crammed

[1] The acuteness of a lawyer in finding the meaning of a document is very wonderful. Almost any mental power can be cultivated to such a very high degree that it almost seems diabolical. A trained person after passing a shop window rapidly is able to describe every object in the window, although the objects may be very numerous and curiously different. Yet this same man may not be at all clever in other ways. In patent cases a clever judge takes in the most elementary scientific knowledge with very great difficulty. The readers of the hundreds of newspaper articles of any morning—as like one another as herrings are awed with their display of culture, of depth of thought, of knowledge, and with, what is more astounding than anything else, an infinitely perfect Oxford polish. Watching the performances of an Oxford man of letters is like watching a good billiard player or a skilled musician. His mind is filled with the thoughts of other men, pigeonholed ready for use. It is extraordinary that a man can have been so educated as to be a good debater, to be able to make a fine speech, that he may have taken a degree at Oxford, that he may have passed examinations in classics, philosophy, and mathematics, and yet be exceedingly ignorant, illogical, and unscientific.

to pass an examination, but after the examination he forgets what he was supposed to have learnt.

The present system of education is to be condemned for other reasons. It is exasperating that all the most important, the most brilliant, the most expensively educated people in England, our poets and novelists, our legislators and lawyers, our soldiers and sailors, our great manufacturers and merchants, our clergymen and schoolmasters, are quite ignorant of natural science; and it may almost be said that in spite of these clever ignorant men, and men like them in other countries, through the agency of scientific men, all the conditions of civilisation are being transformed. I do not think that a fact of this kind would have been neglected by the philosophers of Greece (who scorned to know any other language than their own) or the learned men of Rome, but when some of us direct attention to it and its neglect by modern philosophers we are sneered at as Philistines. It is a curious kind of culture which scorns the lessons of history, the study of man in his relation to nature, the study of the enormous new forces which are now affecting the relations of nations to one another. How many of our rulers know the astounding fact that the cost of the most unskilled work done by man costs 1000 times as much as when that work is done by a steam-engine? Hence it is that the steam-engine has given means for leisure and high culture, yes, and low culture and decadence, to hundreds of people instead of units. And the steam engine enables rulers to spend 100 times as much money on soldiers and sailors and ships and munitions of war as they did 200 years ago.

The university man thinks that he can get some knowledge of science by reading, but without laboratory study he is like the man who said "barley" when he wanted to escape from the robbers' cave and ought to have said "sesame." Do you know the ballad about Count Arnaldos, who envied the old helmsman his weird and wondrous powers?

> "Would'st thou," thus the helmsman answered,
> "Learn the secret of the sea?
> Only those that brave its dangers
> Comprehend its mystery."

I know that the ordinary university man thinks, like the wistful Count, that he can get all things easily or by mere reading. But, in truth, to read the "Origin of Species," or treatises on astronomy or physics or chemistry, is a misleading performance unless the reader brings to the study that kind of mind which has been developed already by his own observation and experiment.

The university man, ignorant of science, becomes a ruler of our great nation, his duty during war and peace being that of a scientific administrator, and without turning a hair he fraudulently accepts this important duty for which he is utterly unfit. The gods must surely laugh when they see these rulers of ours gibing at scientific things, giving important posts to non-scientific men who scorn and obstruct the scientific men who are under their orders. If Oxford scholars were merely like so many monks in their monastery, living the lives and following the studies which they love, I would say nothing. The revenues so used up are, I think, of no great importance to the country, and busy men elsewhere can only be benefited in knowing that at Oxford and Cambridge there are these lovely lamaseries where men are living in serene air apart from the struggles of the world, living what they think to be the higher kind of life, that of the amateur copying the lives of the scholars of Constantinople before they were so mercifully scattered in 1453, copying the meditative ways of the divines and hermits of the fourth and fifth centuries. Unfortunately the Oxford hermits have by a series of accidents become the rulers of the greatest Empire that the earth has ever seen, and it is very obvious indeed through many other things than the starting of South African wars that they are unfit for their job.

If our rulers were like savage chiefs they might possibly give equal chances to candidates for posts; but unfortunately it is as if our leaders possessed great *negative* knowledge of natural science, and as if a man's chances of being appointed to a scientific post or of having his advice listened to were in inverse proportion to his scientific qualifications. Scientific men look around them and see that everything is wrong in the present arrangements, but they also see that it is useless to give advice which cannot be understood by our rulers. And, indeed, I may say that when by accident a scientific man is appointed on a committee there is a negative inducement for him to do anything.

Many men enter the Services by examination, and it is always through cramming that they pass. In some cases the examination is supposed to be in science. In truth, the scientific habit of thought, the real study of science, the very fitness of a boy for entrance to the service, would unfit him for passing these abominable unscientific examinations. For some army posts, further scientific food is provided by the Government for the classical or modern language or science dummies after they enter the Service. If one wishes to hear how evil this system of pretended education is, let him ask the opinion of some of the professors who are condemned to help in carrying it out. The whole system is foolishness from top to bottom, and the men prepared by the system cannot see how abominable it is, even when they are afterwards trying to improve it; well-mannered mediocrity is everywhere successful and reproduces itself.

I have been dwelling upon the consequences of letting aristocratic university men who are to be rulers of the country have an education which involves no study of natural science. Besides these men we have a larger number of middle-class men who will succeed their fathers in the management, not merely of landed estates, but of much more valuable estates in the manufacture and distribution of things. With them there is the same contempt for books, for learning, and the same absence, not merely of knowledge and of natural science, but of those scientific habits of thought and methods of approaching problems which experimental research tends to produce. These men become the owners of factories the spirit of which ought to be scientific research; the competing factories in Germany, France, and America are run by men of scientific method, but our owners discourage reform in every possible way. The rule of thumb of their fathers and grandfathers is good enough for them. Their factories are so badly arranged that the works cost of any manufacture is twice what it ought to be and the time taken is twice as great. They take eagerly to all sorts of quack remedies for bad trade; they are the easy victims of fraudulent persons. These are the men who discourage all education in the people employed by them, managers, foremen, and workmen. They are what I call unskilled workmen—that is, unskilled owners of works—and it is the university and the whole system of their education which is to blame for their unskilfulness. It is astounding how quickly unskilled owners of works are being eliminated, but there is a new crop of them every year. The want of education of these men is very harmful to the country.

But I get too angry when I think of what our universities might do in the great world of natural science and of the futility of almost all their studies. And this anger is greater when I think that the universities rule the schools. The general higher education of the community is being altogether neglected, the general culture of professional men is being neglected; and in

the case of professions involving applications of physical science, useless obligatory subjects are insisted upon, so that for these professions the university is a harmful institution. Medical students have so much hard work in various kinds of grammar subjects required for matriculation that they must be forgiven for their utter ignorance of natural science. But an outside Philistine may also be forgiven when he suggests that the whole country might benefit if the school training of medical students put them more in sympathy with scientific discovery. It is a well-known fact that there are medical men in lucrative practice, said to have the highest university qualifications, who tell you frankly that they do not believe in bacteriology!

A great many young men from the secondary schools are now entering the engineering profession. By engineering I mean any kind of applied physical science. Every important town in Great Britain has established at least one great technical college at large cost in building and apparatus, with staffs of professors and teachers (always badly paid), and it is found that for their first two years the students have to be kept at great cost to the country learning those simple principles of science which they ought to have learnt at school. It is found that they are not only ignorant, but they have none of the habits of thought and scientific method which school laboratory work induces. The clever ones, if they leave school at seventeen, recover from the effects of a school education which prepared men only for being lawyers or clergymen; but the average man finds that he has been prepared only to be a hewer of wood and a drawer of water to the real engineer. It is found in most cases that the successful students are those who have attended primary schools where no boy is compelled to learn any language other than English, and where every boy does laboratory work in mathematics and natural science. There can be no doubt that poor boys have now an enormous advantage over the sons of rich men, for even when the fees of the day classes are large the evening class fees are small, and the poor boys attending the latter are getting to be very fit for higher study in natural science.

The English school system has outlived the medieval conditions which produced it. In old days the only way to knowledge was through Latin: all writing was in Latin. The result then was pretty much what it is now; lawyers, clergymen, and schoolmasters had to know some Latin after school life; the average man forgot anything he had learnt. A few very clever men did read, but the average monk or priest was a very ignorant person.

English people know the worthlessness of the public school system in the mental training of the average boy. Why, then, do they submit to it? However conservative they may be, they would not submit to this worthless system merely because it is hallowed by a history of five hundred years.

The fact is, this worthless system continues because in some occult way it seems to have a connection with something of real importance, *public school form*. There is really no connection. When, in my youth, I was a master at one of the great English public schools, like everybody else, I was a frightful prig in regard to public school *form*. Eton form or Harrow form or Rugby form or Clifton form was the thing at each of these schools which was thought to be of more value than anything else in the world. Dr. Arnold, of Rugby, taught the trick of manufacturing it. It is in itself a splendid thing. The public school boy is trained in self-possession, modesty, cleanliness, truthfulness, and courage. At school his health in body and morals is all-important. He learns to lead and also to obey. But the average resulting man is exceedingly ignorant; he neither reads nor writes, and he has little reasoning power except what his sports have developed. This form is essentially aristocratic. It is based on superiority of position or birth or caste. A man's place is fixed, his attitude to people of higher or lower rank is fixed. He needs no self-assertion, and he cannot become a "bounder," that is, a "cad"; but in Thackeray's sense he is usually a "snob," and in various directions he may be a *prig*. By prig, I mean a man who cannot get outside convention and so cannot exercise his own common sense. One defect is that public school form when combined with poverty cannot make much money by its own ability, and if it does not starve it must join the valets or the grooms. Its strength lies in convention and habit and the belief that poor people are not men but a lower kind of animal who may be pitied as we pity a suffering dog. Such pity can never raise the people or reform abuses. In the Middle Ages young gentlemen of England had the same sort of education. It was probably best in Plantagenet times, when indeed a well-trained young gentleman was not only very healthy and courageous, but he had not much chance of becoming lazy. A man was proud of his heavy armour, and he was trained to act vigorously when carrying it. They were chivalrous to each other, but, alas! to people outside their own class they were cruel. The Black Prince is typical; think of his courtesy to King John of France, and then think of his destruction of the persons and property of all the peasantry in those large regions of France which he covered with his marauding soldiers. This kind of chivalry, which is never exhibited to a lower class than one's own, has its beauty, but it does not suit a democracy; it requires that there should be a lower class than its own. The Spartans needed their helots. The Southern planter in America had fine manners, but he could not have cultivated them if there had been no slaves and mean whites. It is a well-known fact that some years before the Civil War in America it was seriously proposed by prominent Southerners to make slaves of the "mean," that is, the poor whites. The chivalrous Andrew Fletcher of Saltoun showed but little knowledge of his countrymen when he formed his plan for reducing a large part of the working classes of Scotland to slavery. Public school form may sit not unhandsomely upon country gentlemen or any rich men who have many servants or tenants or other dependants, but it does not sit at all well upon poorer men, for it puts them out of sympathy with people among whom they must work. It is heartbreaking when associated with the poverty of a man looking for work in places where he has no influential friends, as it is nearly always associated with illiteracy and want of wisdom, with helplessness and with disinclination to learn. Nobody doubts that a modern country gentleman is much more polished than Squire Western or Squire Lumpkin, but he has much the same opinions and forms them in the same way. The manners of a young officer are certainly superior to those of Ensign Northerton, but he is in much the same state of ignorance. Nineteen out of any twenty young officers, if sent to the top of a hill to observe things, cannot write an account of what they see, and they can hardly describe in spoken words what they see, because their vocabulary is too limited. They cannot write a simple letter in English, although they are supposed to have learnt English in the best way, through Latin. On the day when I wrote the last sentence I happened to see the following statement in the *Times*. It is from an unimpeachable authority, a man whose business it is to teach young officers how to fill up official forms. He was speaking of their ignorance and describing a special instance: ". . . a young officer who shut himself up in a room to write

a letter. At the end of two hours he was found sitting, very pale, before a large sheet of paper, on which he had written, 'I say Cox'—'Cox' being the name of the regimental banker." He did not know even how to begin to write a letter.[2]

We ask the schools for mental power as of old one asked for bread, and they give us a stone. No doubt public school form is a beautiful stone, a diamond; but we want some bread as well, even if it were only in the Falstaffian proportion of bread to sack. For my part I do not see why the average boy at school should not have reasoning power and a love for reading and knowledge as well as good manners, and this is why I ask for a great reform in our schools. We want from the school what nature has not been accustomed to give, and what home life cannot give, the development of the intellect, and the school fails to give it in ninety-five out of every hundred cases. The great danger in school life is that it may hurt individuality, originality, because a boy, however harum-scarum, is naturally conventional and imitative. Good form comes easily, therefore, and the master is more than satisfied, he is proud. He often speaks of it as *character*, but he is quite wrong. Character comes from home life, not from school life, which indeed is rather antagonistic to character. It comes from contact with fathers and mothers, brothers and sisters, relations and friends. School life tends to induce a contempt for the lower classes and a slavish admiration of the upper classes, which is altogether wrong in a democracy, and can only lead to evil.

It always happens that the real education of the average man begins when he falls in love and sees the necessity for writing love letters. He must have spent many years of worry at school and passed examinations in Latin and mathematics, perhaps in French or German, in geography, and many other subjects, all taught in water-tight compartments, yet he is quite illiterate. If he has been slightly higher than the average boy he is able occasionally in after life to quote one or two tags from the Latin grammar and to say that he thought he remembered something of the *pons asinorum*; he is also fond of using the expression, "the unknown quantity *x*," because it shows that he once worked at algebra. A Premier of Great Britain who had sent out a great military expedition to Cape Breton expressed great delight afterwards when he suddenly discovered that Cape Breton was an island. Chancellors of the Exchequer have shown themselves to be quite ignorant of the simplest arithmetic. A very successful Cambridge coach told me that it is quite common for the father of a pupil to tell him that he does not wish his son to get a good degree. Generalisation is always dangerous, but I think I am safe in saying that Englishmen of the higher classes do not believe in education. They believe in what they call character, which always to them means public school form, and they believe in mental mediocrity, which in most cases means mental inferiority. This gives one explanation of the persistence of the public school system. The man who remembers his years of dull school classroom routine with no intellectual result is not likely to be enthusiastic over the education of his son.

Unfortunately all secondary schools try to copy the public schools. They also aim at teaching good form, mainly by magnifying the importance of football and cricket. To differentiate themselves from the primary schools, they compel every boy to learn through Latin. And all this they do at a rate which suits the pockets of the lower middle-class parent. It is a poor imitation of a system only one part of which is worthy of imitation.

I can understand why Tom Sawyer and his friends, when they started their gang of robbers, initiated them through passwords and a ritual. That was for "side." The gang did not consist of pirates or robbers; they were innocent young boys, and their passwords and ritual were the essence of the romance of the thing. Latin for the average youth seems to me to be merely grown-up Tom Sawyerism, and is allied in obvious ways to the worship of Mumbo-Jumbo. It used to be that the use of fur on clothes was reserved for the higher classes. At another time gentlemen only were allowed to wear swords. In China and Japan certain buttons and coloured dresses indicated certain rank. In our own time there are fashions of slang which distinguish the smart set of society. The survival of Latin and Greek is very much the same sort of thing. It has no more to do with education than the two hind buttons of our coats or the wigs of our judges have to do with convenience. The classics ride us like Sindbad's old man of the sea. All over the British Empire a well-educated man cannot become a professional man of almost any kind unless he pretends to know something of one or more dead languages, such knowledge being of no essential value to him. It is something like what the old Test Act imposed upon us; for 130 years a British citizen perfectly competent to fill the highest posts could not take upon himself the smallest kind of public work unless he could swear to a certain formula. Most of the numerous students of a very important school of mines refuse to take their B.Sc. degrees because they are wise enough to refuse to learn Latin. The mine-owners are wise enough to engage these men if they possess only the college diploma, although they have no degree. There is scarcely one mining engineer holding a university degree in the country that I speak of. Indeed, I may say that only a few mining engineers in Great Britain hold a university degree, and this is for the same reason.

If there is any particularly useless, poor, genteel clerk you will find that his son must be taught Latin. If there is any little township in a new country where everybody is ignorant, the schoolmaster must teach Latin. Any cheap schoolmaster, knowing nothing, worth nothing, will, you may be sure, say that he can teach Latin. If there is a particularly illiterate bar-room loafer in the town who never reads books or newspapers you will find that he has a stock-in-trade of perhaps three Latin phrases which keep him provided in beer.

Do you know why Portia the Maid of Belmont remained so long unmarried? It was because her suitors assumed that the golden language of conquest was Greek and the silver language was Latin. If you read between the lines you will see that this is what Shakespeare meant. His leaden casket signified the English of Belmont-cum-Stratford-on-Avon.

The worst of it is that the average boy who has done almost nothing else than Latin and Greek at school gets absolutely no love for the classics; he never reads a Greek or Latin author after he leaves school. He might enjoy them in translations, but he hates their names, and even if he did not it would never enter his

[2] The Report of the Commission on the Education and Training of Officers of the Army (1902) is well worth study. Dr Maguire, the most experienced coach, said, as a witness:—"Latin, as taught to the average schoolboy is pure waste of time, and does not develop intelligence or tend to breadth of culture in the least or facilitate the acquisition of modern languages." . . . "The prominence of ancient classics in English schools and the large proportion of youthful years devoted to failure in regard to them explain the stupidity and incapacity of their pupils as compared with the same class of persons in other advanced communities." . . . "They [classics] are kept in such vogue to suit the convenience of languid schoolmasters who can teach nothing else, and for no other reason whatever." He spoke of "the absurd anachronism of lazy and costly schools, which rendered so many of us ignorant of the very subjects which are generally useful and interesting." He said: "but our educational system all round is utter folly at best." Speaking of English Universities, "the whole system is a grievous absurdity." "'Society' and snobbery are the curses of England."

head to read a "crib." Surely this is the natural effect of the schoolroom routine.

Following that article in the *Times* newspaper, referred to above, in a discussion, the secretary of the Association for Improving the Teaching of Latin said, "Out of the vast number of boys who learned Latin only a few reached the stage when they could read the classics with any pleasure. A still smaller minority continued their classics after they had left school or the university. The great majority left school with very little, if anything, as the result of years spent in the study of the classics." The next speaker said that the reforms suggested "were based upon the assumption that the present method of classical education was wholly bad. He did not agree." Nor do I agree. I think that if there is one subject that the ordinary public schoolmaster can teach it is Latin. I take the first statement as right, however. I have always said so, loudly, to an unbelieving world that thought me prejudiced, and here we see a lover of the classics inadvertently supporting me, and surely every fair-minded schoolmaster must agree with him, at all events concerning the average boy. It is not the method of teaching that is wrong; it is merely that Latin as a school subject for the average boy must be altogether condemned. It takes from him all interest in every kind of literature; it makes him dislike reading. We must have some compulsory subjects, and I think that any boy may be taught any subject —to some extent; but we ought to have as few of these compulsory subjects as possible, because any subject may be found very difficult by certain classes of intelligent minds. And it is surely ludicrous when a clever mathematician, well read in natural science and fond of English literature, is plucked for his degree because of his poor Latin or Greek. I knew a case where the first classic of his year would have failed to pass his "Little-go" only that special arrangements were made to let him through his mathematics easily. My own career was nearly ruined because I failed in a French examination.

Before a student enters a university he has to pass a matriculation examination, so that we may be sure that he is fit to follow any of the courses of study. In medieval times the one compulsory subject was Latin, because all the literature known to students and teachers was in Latin, all lectures were delivered in Latin, all teaching was in Latin. Consequently in some Oxford colleges a man was fined if he spoke in any other tongue. Then came the time when there was still no English literature, and not only was the best literature in Greek, but Greek was the only approach to natural knowledge, so Greek also was compulsory, and so it has remained to this day—to this day when English literature (including translations) is of greater worth than any ancient or, indeed, any other modern literature; when all teaching, all lectures are given in English, and when our English knowledge of natural science is not only infinitely greater than anything possessed by the ancients; but it enables us to say that the ancients were hopelessly wrong; when nobody but the official university orator or some traveller ignorant of the language of a foreign country speaks Latin and then speaks rather the language of Stratford-atte-Bow than the Latin of the City of the Golden Shields. The men of the City of the Violet Crown were not handicapped by being compelled to learn any other language than their own, to waste their time on mere words; "they were engaged in pursuits of a higher nature, in acquiring a knowledge of *things*. They did not, like us, spend seven or ten years of scholastic labour in making a general acquaintance with two dead languages. These years were employed in the study of *nature* and in gaining the elements of philosophical knowledge from her original economy and laws." The above quotation is from the Langhornes' "Life of Plutarch," and it is particularly valuable as expressing the views of two great classical scholars.

I would make a knowledge of Latin or of Greek compulsory only on students of certain subjects, and the professor ought to impose the condition, not the university. Again, students of certain other subjects ought to know one or more foreign languages, and, indeed, it seems to me that the professor in each subject has a right to insist on his students having certain special knowledge before they enter upon a study with him. But to enter the university, surely the compulsory subjects ought to be as few as possible. It seems to me that the most important thing is to make sure that every student has had an early education through his own language—English; that he should be able to write an account in English of anything he has seen; should have some acquaintance with what are called English subjects, such as geography and history, and the principles of natural science, and the power to make simple computations. All the teaching is to be in English, all his companions speak English; there are good English books on all subjects, there are English translations of all the good books that have been written in foreign languages. So abominable do I think *compulsory* Latin or Greek or French or German that I believe a primary school to be a much better school than any other for a boy if he is fitting himself for any profession in which applied science is important. At present English is not taught properly in any British school. The teachers are all classical men, who are very careful when they write Greek or Latin and exceedingly careless and slipshod when they write English. We might easily write a fairy story about three sisters—Greek, Latin, and English—and call it "Cinderella." The language of the greatest Empire known in history, the Empire of the English-speaking peoples, is not taught seriously in any part of that great Empire. It is shocking to get from a great classical scholar a letter with misspelt words on every page, every sentence being ungrammatical. When will our good modern writers tell us how English composition may be taught to ordinary folk?

I want you to understand that we have established some fundamental principles in our science: (1) A subject must interest a pupil. (2) A man who trains dogs or seals or bears or other animals makes a close study of their minds. In the same way we must recognise that one boy differs from another, and study the mind of each boy. (3) If a boy is not very receptive of an important subject we must do our best with him and try to settle what is the minimum with which we ought to be satisfied. Only a few subjects ought to be compulsory on all boys. (4) There are two classes of boys unequal as to numbers, (*a*) those fond of, and (*b*) those not capable of abstract reasoning. (5) Another two classes are (*a*) those fond of, and (*b*) those not fond of language study. (6) Every boy may be made to write and read in his own language and he may be made fond of reading. (7) The average boy's reasoning faculties are most surely developed by letting him do things. That is, for example, through his sports, or through wood or metal working, or gardening, or experiments involving weighing and measuring. Through the last of these he learns to compute. A boy of eight learns decimals in an hour if he weighs and measures, whereas by the usual method of teaching he is ignorant of decimals at the age of fourteen. A boy learns whist very quickly if you seat him with three other people at a table with a pack of cards; he would not learn in a month if he had no cards. Would you teach a boy to swim by mere talk? (8) Every boy must get a good deal of personal attention. (9) However good a system may

be there can be no good results if the teachers are cheap; cheap teachers are usually stupid and overworked. Men in charge of schools and colleges never seem to learn this. The market price must be paid for a capable man. (10) Fairly good results may be expected from a good teacher, even when he is compelled to work on a bad system, but really good results can be obtainable only from a good teacher with a good system.

I need not go into details about all these principles, but I should like to dwell presently upon a few of them. At the beginning of this address I spoke of the obstruction to great necessary reform—too much antiquated machinery to "scrap." Most schoolmasters will admit the necessity for reform in the case of the average boy, but they say that parents are opposed to the reform. Unbelief in education for the average man is so general among the higher classes that I am afraid we shall have no reform unless some great national disaster causes conversion. There is a lesson for England, and, indeed, for all European races, in the recent history of Japan. The old structure of Japan was in many ways beautiful, but it proved to be without physical strength. Its extreme weakness proved its salvation. Even the teachers of ancient classics saw that for strength it was necessary to let scientific method permeate the thought of the whole population. And now, at the end of the first chapter of Japan's modern history, we find a nation which can not only defend itself, but which retains all of its spiritual life which was beautiful. Every unit of the population can not only read and write, but it is fond of reading, and its education did not cease when it left school. It is getting an increased love for natural science, so that it can reason clearly; it is not carried away by charlatans; it retains its individuality. One result of this is that in time of war Japan has scientific armies. Not only are its admirals and generals scientific, but also every officer, every private is scientific. Everything in the whole country is being developed scientifically, and we Europeans, hag-ridden by pedantry in our schools and universities, refuse to learn an easy lesson. At present we do not even ask what is meant by education or what education is necessary if a particular boy is to be fitted for his life's work. In 1902, when I was president of Section G, and in opening a discussion on the teaching of mechanics at Johannesburg in 1905, I gave my views as to the teaching of a young engineer, but they apply also to the teaching of nearly all boys. These views have been commended by experienced engineers and teachers. To understand me it is first necessary to try to cast away prejudices, and this is especially difficult if one has a pecuniary interest in education. The student of almost any other science than education cares for nothing but the truth; even when he has committed himself to a theory and his good name or credit is at stake the rule of the game is perfectly well known and must be adhered to. The student must not neglect fact or pervert fact; he must be quite fair. The student of physical science sees at once whether or not he is playing the game, because the coordinates are few; there are no complexities, such as we find in our own life problems. This also is why the study of physical science is so good in causing boys to reason, for reasoning can only be taught by constant practice on simple matters which one thoroughly comprehends. Consider a boy's views about ordinary affairs. He is downright. A complex thing must be greatly simplified to him. His painting is in black-and-white; there is no delicate shading in his picture. He never sits on the fence; he is never a trimmer. An historical character is awfully good or awfully bad, very clever or very stupid. A boy is, in fact, cocksure about everything. He is incapable of reasoning about complex things. And when we try to teach him to reason about simple things we must be quite sure that they really are simple to him, that he understands them. For example, many educationists say that the study of geometry is just right for a boy. Well, yes, for 5 per cent. of all boys, boys who can take in abstract ideas. They take to Euclid as a duck takes to water. But for the other 95 per cent. geometry is very hurtful, because unless they continually experiment with rulers and compasses they do not understand what the reasoning is about. In ancient times only very old and exceptionally clever men were allowed to study geometry. We now assume that it ought to be an easy study for the average English boy. Generation after generation we stupefy the average English boy with demonstrative geometry, and we call him a duffer so often that he thinks himself a duffer, and even his mother thinks him a duffer, and, inded, we have done our best with geometry and Latin to make him a duffer. Only for his football and cricket, which teach him to reason a little, he would become a duffer. And yet in my opinion if this average boy were properly taught in school he would prove to be very superior to the boy who is usually called clever. The schoolmaster calls a boy clever because he is exactly like what the schoolmaster himself was when a boy; but I am afraid that I place little value on the schoolmaster's cleverness, whether as a boy or a man. Reasoning can be taught through almost anything that a boy does, but more than all things through his experiments in natural science. Formal lessons on reasoning, on logic, are utterly useless, and I may say that set lessons on almost any subject are utterly useless for the average boy.

Milton's poems are greatly praised. Well, I am not going to say a word against the people who talk in public about the most wonderful epic in our language and who never read it; but how many people have read Milton's magnificent prose works? Milton first taught me the true notion of education, that the greatest mistake is in teaching subjects in water-tight compartments. It is the idea underlying one of the most instructive books ever written, "Sandford and Merton." When teaching a subject, teach all sorts of other subjects as well. If Mr. Barlow's boys were interested in astronomy he showed them stars and planets through a telescope for a night or two, but he gave them no stupefying course on astronomy. He gave them stars and the solar system just as long as they were interested. He used a globe as well as mere maps in teaching them geography and history, but the soul-destroying idea of a course of study on "the use of the globes" did not commend itself to him. They walked over the fields and took an interest in trees and flowers, but he gave them no stupefying course on botany. When he gave them a lesson on English grammar or literature he taught them at the same time the geography and history and the fairy stories of their country. How can a man give a course on grammar or geography or history or anything else without diverting his talk in an interesting way to other subjects? What is so tremendously important about natural science laboratory work is that a student must be thinking all the time about the same matters, not from one but from ten interesting points of view. He is not merely observing, he is measuring, he is computing, he is reasoning; he has to write out descriptions of what he sees and does, and he thinks then of his spelling and grammar; he has to sketch; he has to read books about what other people have done before him on the same subject, and also

for statistics. He learns the value of a bit of work done in a clean honest way, and when he gets some more experience he glows with the feeling that he has really added to the knowledge of the world. He is a discoverer, and he feels the emotion of Cortez! It is marvellous the alteration which has occurred in the mental attitude of the common average boy. Instead of feeling that he is a degraded slave he feels the emotion of his childhood returning to him. He once made the great discovery at the age of six that the back garden was inhabited by fairies and lions and Indians and pirates. He was the Caliph Haroun Alraschid for a while. And now, after a wretched life at Latin and Euclid, a new revelation is vouchsafed to him, and as he gathers years he finds that nature is placidly willing to let him steal her secrets little by little, one by one, secrets that are gradually changing men from the bewilderment and spirit possession of the Middle Ages; so that at length he enters into complete communion with nature and rollicks with her, and quarrels with her, and loves her more and more until he dies. And his reasoning power has been growing all the time, so that more and more he understands complex things, for, after an experimental study of story-books, he probably entered the kingdom of Shakespeare at the age of fourteen. Things requiring memory can be learnt only in early life—weights and measures, the multiplication table, languages. He knows games involving spelling. But, over and above all these, he has from infancy repeated all sorts of poetry long before he could enjoy much more of it than the jingle of its rhyme.

Education consists in the development of a man from his earliest day, and does not cease until he dies. Any thoughtful man must see that there is no science so important as that of education, the preparation of children of this generation to be the citizens, the rulers of the country, in the next generation. The whole future of our Empire depends upon the education of the children. By the study of this science we hope to improve teaching so as to make future citizens not only to have more knowledge and more skill, but to make them wiser than the people of the present or the past.

Early training determines what later training ought to be. Let us consider what the early training of a boy ought to be. In his very early days nature has provided that his education shall proceed very rapidly by observation and experiment, and the only teaching needed is through careful nursing and affection. He teaches himself, and he loves to learn. He ought to get toys not too realistic, for he loves to weave romance round his toys, but still things to observe and experiment with. He has most complex problems in physical science when he is only a few weeks old, the solution of which involves much labour, but it is pleasant labour and he is happy. And he will remain sweet-tempered and happy and unspoilt if there is real affection from his teachers. If, however, somebody teases him by playing practical jokes, or if a selfish mother who was unreasonably kind to him yesterday is unreasonably unkind to him to-day, he gets, because of his reasoning power, a sense of injustice. Man, woman, or child with a sense of injustice may be said to be possessed of a devil. During the first six years of a child's life the creation of its power to reason is more wonderful than anything else, and this reasoning power comes altogether by observation and experiment. An affectionate parent easily finds methods of helping nature in this process. The unspoilt boy of six years seems to forget nothing that he hears; he has gathered a most wonderful vocabulary; he knows endless nursery rhymes and simple poetry; he is as active and adventurous as a kitten, and everything he does is cultivating his senses. This is the time when he fills the smallest playground (which to grown-ups seems bare and desolate) with giants and fairies and Indians and pirates, with forests and mountains and rivers and oceans. His imagination is so extraordinary that the most uncouth creation of his own gives him exquisite pleasure. Why do I dwell upon this stage of a boy's development? Because it has been so perfect. Nature has learnt to do this to children during perhaps hundreds of thousands of years, and it has been the most important time of a boy's life, the time when, if parents will only give the boy their love and greatly let him alone otherwise, he develops mentally more than during all the rest of his life. Speaking broadly, he has done nothing in all this time except what nature and affection made pleasant to him. I have studied the science of education and practised the art of teaching all my life, and I say that all our failures are due to our neglect of nature's methods, and our schools destroy the good effects which nature has produced.

As a rule I do not like to be told that certain subjects must be compulsory, but surely every child of eleven must have some such qualifications as these: (1) The power to speak and read and write in his own language. (2) To be able to do easy computation. (3) To have an exact knowledge of the simplest principles of natural science from his own observation and experiment. I think that every observer must acknowledge that these powers are possible for almost every boy of eleven. Some of us have for many years been endeavouring to show how the child of six may acquire these powers by the age of eleven if nature's methods—that is, kindergarten methods—are followed. For example, he plays at keeping shop, selling or buying things by weight and measure, and paying or receiving actual money and giving change. He weighs and measures with greater and greater accuracy as he makes experiments in mechanics and heat and chemistry. Every boy is fond of stories, and if treated reasonably is easily induced to learn to read. Reading aloud is easily made a pleasure and a habit, and so the boy learns to speak properly. Any boy whatever will become fond of reading if the people about him are fond of reading: I state this as a fact which I have investigated. A boy who is fond of reading gets later on to know the value of books and the use of books, and he will go on educating himself until he dies. Any attempt at coercion, unless it is the very gentle coercion of a person whom he loves, is fatal; even coaxing is not always good. He assimilates knowledge from everything which he does, and therefore he ought to be induced to do things which not only keep him healthy, but which give him knowledge and teach him to reason. Do you remember how angry Lanfranc of Bec was at the idea that any pupil could be *forced* to learn; he said "it turned men into beasts." I speak to you who love children, who love young people, who know that there is scarcely one child in a hundred, even among rather spoilt children, who does not love to do his duty.

Under the best and most loving of teachers a lonely child has enormous disadvantages, but these can generally be remedied. The usual mistake is to send it to a large school. If it is merely a day school there is no great harm. But no child under thirteen ought to be sent to a boarding school unless it is a small school and the master and his wife have a love of sympathy for other people's children. There are such people in the world, God bless them! but they are not numerous. They are so few that we must return to nature as the best of teachers. The time is coming when a child's own father and mother will have much more knowledge and wisdom than they have now, and they will refuse to give up to others the doing of their highest duties. It is at present not sufficiently recognised that

the most important duty of the parents is the education of their children. At present, men who are building up fortunes are too busy to think of their children, and so we find that the sons of Lord Chancellors and other successful men have been marrying chorus girls and squandering those very fortunes to which their education was sacrificed. Of course, if parents are uneducated, and therefore selfish or otherwise foolish, any kind of school may be better than home for their doomed children. It is one of the great advantages of poverty that the children go to day schools and they keep in touch with home life. If the day school is really a boarding school as well, it will be found that there is always a differentiation in favour of the boarder, which has a very bad caste effect, just as the "modern-side" boy of any public school suffers in character because he is of a lower caste than the classical-side boy. It is usual to remove a stupid classical-side boy to the modern side, and every boy on the modern side has a sense of injustice. The work of the modern side ought to be much the higher, but it is always badly done because the atmosphere is altogether bad.

It may be said that I am only destructive in my criticism of public schools. I think it will be found that I am also constructive, although I acknowledge that my sketch needs much filling in. Well, can much more be done in an address lasting one hour? I will now try my hand at a little filling in. I have no objection to the existence of classical schools something like the present for boys who are fond of classics. The average boy will not be asked to attend such a school. I feel sure that much greater attention ought to be paid to the teaching of English composition, to English poetry and prose, and to English subjects generally. I also feel sure that much attention ought to be paid to natural science. And surely it can do no good for the classical masters to go on sneering at natural science subjects and calling them "stinks" as they do now.

I want, however, to speak more particularly of a much higher kind of school, which will educate the boy usually called clever and also the boy usually called stupid. As I have already remarked, I think that these names may sometimes be redistributed.

The school is one for boys from eleven to sixteen years of age. It ought in no way to be connected with any classical school. English subjects will predominate, but teaching in Latin and Greek and modern languages and other alternative subjects will be provided, although they will not be forced upon any boy. The masters who teach English ought to know enough Latin and Greek and Celtic and Old English and modern languages to be able to illustrate the derivation of English words through their roots. And they must be well read in English subjects and fond of English literature. They will make the boys fond of reading English, and encourage them to find out what they like best. Some boys will take to history and philosophy, some to poetry and imaginative literature. Every boy ought to get the best chance of developing his faculties. It may be asked —if we cannot make the average boy spend or waste twelve hours a week on Latin, what are we to do with him? At all events, now, we keep him doing something, even if it is only marking time. My answer is, you think only of his putting in time; well, then, let him put in his time at work that interests him; any work of that kind must be educative under an intelligent master who can help him in his studies if it induces him to look up information for himself. Thus, when reading travels or history, he will use the globe and raised maps and read geography, and hunt up plans of battlefields. Think of the things that a boy used to be punished for doing, and let him do those things under wise direction. I used to be punished for reading Scott and Cooper. Nowadays prizes are given to boys for their knowledge of Ivanhoe or Quentin Durward. Expand this into a system. A boy who loves to browse over Chambers's English literature ought to be guided in his browsing, and induced to take up something more than selections, and he may easily be induced to get off selections by heart if his teacher does not show his contempt by speaking of such exercises as *Rep.* (repetition).

Let the teacher take a leaf out of our methods of teaching chemistry and physics. It has been shown that twenty-five boys doing work in the laboratory during a lesson of an hour and a half or two hours can be managed by one teacher. Experimental lectures in a lecture-room have now been greatly discarded; such lessons as I speak of take place in the laboratory, but reliance is placed particularly upon the personal attention of the teacher being given to each group of students in charge of an investigation, the group not being usually greater than four in number, and often being less than two. These students are sometimes merely verifying or testing a statement made by the teacher or found in a book, but they are often finding out things for themselves. One idea underlying the work is that there ought to be more and more illustrations of simple fundamental principles. It is long before these simple things really become part of a boy's mental machinery; things like the mere definition of *force*, for example. It is, of course, quite different work for the teacher from anything that he used to have to do; for one thing, being much more exhausting. He cannot shirk his duties and sit down waiting for students to come to him. When teaching degenerates into mere maintenance of discipline, everything being regarded as right if the pupils are quiet and seem to be diligent, it is necessary to make a radical change, usually a dismissal of the teacher. It used to be that a science master gave an experimental lecture, and afterwards he had a very easy time, letting the students follow a set routine in the laboratory, but this will no longer do; such attendance at lectures and laboratory work means poor mental training.

Now, I would work out a system for English, English composition, English poetry and prose, geography, history, and other English subjects, on the lines that we have found so successful in natural science. An enormous change has been effected during the last fifteen years in the teaching of mathematics. The older methods always failed with the average boy or man. The new system, which is sometimes called *practical* mathematics, is based on the idea that students shall work experimentally, just as they do in their natural science. It is found that their eyes and faces are bright, they work hard, and they evidently enjoy their work. We have merely introduced common sense into the teaching; we have approached the student's mind from other points of view than the old academic one, from the only side on which he has ever been taught anything—the side of observation and trial. He weighs and measures. He does experimental geometry and mensuration, and is assisted by abstract reasoning just to the extent which interests him; he makes plans of the school buildings and maps of the district; algebra becomes interesting when in coordination with experiments in mechanics and physics; trigonometry becomes interesting in the actual measurements of heights and distances. The infinitesimal calculus is bound to be a weapon which any boy of fifteen easily gets to understand by actual use when he is dealing with dynamic experiments. In fact, the physical and mathematical laboratories

are in one, and the same teacher takes charge of both subjects and teaches them as much as possible together.

Furthermore, in the preparation of an account of an investigation there are practical lessons in English composition; there is sketching, and also more careful drawing with instruments, and the finding of empirical laws, using squared paper. In such a school every subject is being taught through all the other subjects; every boy is doing the work in which he is greatly interested, and no boy is attending merely and putting in time. Furthermore, out of school-time there might be the usual restrictions as to "bounds," but otherwise I would let a boy do pretty much as he pleased. "Prep." at boarding-schools and home lessons for boys at day schools are to be quite discredited. I would—it may cost a little more money—allow a boy to work in the workshops or laboratories or library or in his own room or common rooms at anything he pleases in this off-time, and I would give him advice only if he asks for it. If I saw a boy reading a penny dreadful I would not stop him; nor if he were reading Paine's "Age of Reason," or any wretched treatise on psychology or logic. I would in no way discourage a boy from acquiring a greater and greater fondness for reading, knowing that this is the foundation of future happiness and education, and that no harm which he can get from his reading is of the slightest importance in comparison with the importance of our main object. As he grows up he will become less and less fond of the sixpenny magazine. The school can at its best be merely a preparation for the lifelong education of the man. I would not keep the boy at school after sixteen. Let him then go into business, or to a science or technical school, or to the university.

Unfortunately for the present no university will take men without an entrance examination involving other languages than English. This is a great evil, but it is not going to last much longer. In the meantime a competent coach will prepare any student to pass the necessary examinations (say, in Latin and Greek) in three months, even if there is much other work to do. This is not a matter of learning any classics; it is rather the manufacture of some contempt for the classics, a necessary evil for the present. Indeed, for the present, but let us hope not for long, there are many other necessary evils. We have to find competent enthusiastic teachers, we have to persuade governing bodies to pay salaries two or more times as great as at present, we have to make parents see that some mental training and fondness for reading and writing are really of value, and that Tom Sawyerism is only childish.

The importance of primary education is now well recognised. Rich and aristocratic folk know that they are now in the hands of the common people in a democratic country, and it is important to see that the common people shall be made fit to rule and shall have a real sense of fairness and reasonableness. Above all, if they are to be good citizens we must cultivate their common sense. I think that in the schemes and the administration of primary education by the Boards of England and Scotland it is in a good way; but there is one great curse upon it, and the enormous sums of money spent upon it are greatly wasted. The local authorities give to every teacher far too much to do, and they give him only half his proper wages. In a few years the Government of our democratic country will be in the hands of the boys now at school. That they should be good citizens full of common sense is more important than any other thing. If they are without fondness for books, and if they cannot reason, their votes will be at the command of fraudulent or foolish, or perhaps only selfish or self-deceiving speakers. Our Empire was ruled by George III., and by God's grace we only lost America and piled up the National Debt; but think of an empire ruled by millions of Georges! Teaching the young requires great wisdom and sympathy, and we entrust it to people paid half wages, the "otherwise unemployed." In the secondary schools also we find this penny wise pound foolish policy, and it is particularly evil in the great technical schools. A city is proud of its magnificent college of science, first because of its architecture; secondly, because of its equipment in apparatus, perhaps in steam- and gas-engines and other expensive machinery. And the man in charge of the most important department of that college receives perhaps 250*l.* a year. He ought to get at least 600*l.* That is the market price of a fit man, and without a fit man the whole money and the time of students are being wasted; the thing is really a fraud, a whited sepulchre, and, of course, the principal is always a classical non-scientific man. Photographs of the building and its laboratories are very fine to look at in guide-books of the city, and the managers of the college get public thanks for their services. I know nearly all the technical and science colleges of Great Britain, and I scarcely ever see any of their complacent managers, members of their governing bodies, without wishing that I had some of the powers of the familiars of the old Spanish Inquisition. What right have they to undertake duties which require a knowledge of natural science?

The latest proposal of our callous copiers of the Germans is to make attendance at evening classes compulsory up to the age of seventeen. At present working boys attend evening classes voluntarily, although in many cases they are too tired to learn much. Yet many of them do learn. These boys are almost martyrs. They sacrifice so many of their poor pleasures, and indeed duties, that they certainly deserve success in life. But it is not fair to impose these sacrifices upon boys who are, as apprentices, learning the principles underlying their trade, and who are paid only small wages on the understanding that their masters teach these principles. In 1889 I introduced a Bill into the Kensington Parliament compelling employers to provide such instruction during the working hours. Reforms of all kinds proceed with exasperating slowness, but already many employers are carrying out this idea.

In some things we reformers have made way. It is now recognised almost everywhere that examinations ought to be conducted mainly by the teachers of a student. I have often put the matter in this way: Huxley used to teach about forty students in biology; we cannot imagine better teaching. But if those students had only wanted to pass the examination of London University it is quite certain that they would have done very much better by attending the class of a cheap crammer. A university consisting of two, three, or more federated colleges is very little better than a mere outside examining body, and this is what London University has always been. I am glad that a change towards something better is now about to take place. A number of separate universities would be better, but in two years or less, probably, the colleges of London will conduct their own intermediate and degree examinations. One result will be that when a man gets his degree he will not shut up his books for ever.

I would, however, point out that Old London University, which was a mere examining body, served an exceedingly important purpose. This statement may seem curious coming from a person who has always railed at London University as a mere examining

board. I still say that it was never a University at all in the past. But a man reading hard by himself, perhaps far away from a college, could have a severe test applied to his acquirements which encouraged him in his studies when he had no other encouragement, and the test was very rightly a severe test. To do away with its outside examinations altogether, as I believe is the intention of the authorities, will be exceedingly harmful. It would be impertinent in me to make a suggestion as to the distinction which might be made between a degree conferred by his own professors upon a man who has attended regularly a college of repute, and a degree conferred by a mere examining body upon an outside student. For the first, the examination test may be easy. The Oxford and Cambridge pass degree examinations are quite easy, and rightly so, for the real qualification is that an undergraduate shall have lived for three years in the intellectual and cultured life of an Oxford or Cambridge college. In the other case the mere examination is the only test, and it is rightly very severe. The two kinds of degree differ altogether in quality. In a new country of great distances I can imagine many good secondary schools to be established having neither sufficient funds nor sufficient pupils to be qualified as universities. Yet it may be of enormous importance that a few of the older pupils at such schools should as external students be examined for degrees by distant universities, which, in such a case, are merely outside examining bodies. I can see the gradual increase in importance of such secondary schools leading to the establishment of something higher—namely, colleges of university rank—and I can see such affiliated colleges becoming universities themselves perhaps after a period in which two or more of them federated themselves as universities. But I say that there ought always to be some examination machinery by which a student who is too poor or who through any other circumstance is unable to attend a university college may be encouraged to study by himself, by having his attainments tested.

In this address I have said nothing about the education of women. I have always advocated higher education for girls, but it is surely wicked to teach girls as if they were boys. Men are concentrative, and they specialise; women observe more and more about many things, and they really have more capacity for acquiring mental power. Until quite recently girls were saved from stupidity, but the high schools are now giving a crammed knowledge of facts and of the opinions of the tribe, so that girls and women are ceasing to think for themselves. The education of men is in a bad way, but that of women is becoming much worse.

I think that in this address I have put forward no idea that I have not already published time after time in the last thirty-five years. I put these views forward again because, after much thought and much experience, I still think them to be correct, and I feel sure that they must prevail. But I must confess that it is only a very hopeful man who can peg away at a thankless task as Dr. Armstrong and I have been doing so long.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

GLASGOW.—Dr. A. W. Stewart, lecturer in organic chemistry in the Queen's University of Belfast, and formerly lecturer in stereochemistry at University College, London, has been appointed lecturer in physical chemistry at the University of Glasgow, in succession to Prof. Soddy, now of Aberdeen.

By the will of the late Major-General Tweedie, his estate of Lettrick, in the parish of Dunscore, having an annual value of about 180*l.*, is bequeathed to the University of Edinburgh. The annual income is to be applied by the University to the establishment of scholarships for research into the early history, development, and religion of Eastern peoples; or in such way as may seem best suited to advance that branch of study.

THE leading article of the August issue of the *Reading University College Review* deals with the teaching of applied science, and the question is considered from the point of view of chemistry. The writer urges that given a due knowledge of pure chemistry, all that is required for the mastery of any branch of applied chemistry is concentration on those analytical methods and physical problems which belong to it. Thus to succeed in any applied branch of the science a man must first be a pure chemist. He goes on to argue that the system of instruction in applied sciences followed in this country attempts too much and does too little. The syllabus should be restricted, while more time should be devoted to general principles. The applied part should not be taken separately, but should be interwoven with the rest and used to illustrate it. Speaking generally the student of applied science will profit most if his work in pure science is designed to give him adequate training in scientific method.

THE calendar for 1914–15, that is, for the ninety-second session, of Birkbeck College, London, has been received. Full provision has been made for continuing the work of the college during the present academic year in the direction of supplying approved courses of instruction for degrees in arts, science, laws, and economics of the University of London, and offering other important educational facilities. The usefulness of the college is much curtailed by its limited accommodation: its pressing need is for increased space. More extensive college buildings, with additional classrooms and larger laboratories better adapted to modern requirements, would give a great stimulus to the work of the college and add to its public utility. Attention is directed in an introduction to the calendar to the final report of the Royal Commission on University Education in London (1913), in which the Commissioners write (section 248): "We think that the original purpose of the founder of Birkbeck College and the excellent work that institution has done for the education of evening students who desire a university training, mark it out as the natural seat of the constituent college in the faculties of arts and science for evening and other part-time students."

A COPY of the annual report, for the year ended March 31, 1914, of the Education Committee of the County Council of the West Riding of Yorkshire has been received. The report contains much evidence of sound progress during the year. The arrangements with the Universities of Leeds and Sheffield under which, in virtue of the general grants made by the County Council, certain definite work is undertaken by the universities and certain free places are reserved for nominees of the County Council, have been continued. In addition to external lectures on coal mining, given by the University of Sheffield, both Universities have been engaged also in the organisation and supervision of classes in coal mining, the Leeds University in the area of the West Yorkshire coalfield, the Sheffield University in the area of the South Yorkshire coalfield; and each university has made provision for the training in mine-gas testing, of persons selected by the committee as prospective teachers of this subject. The Joint Agricultural

Council of the three Ridings of Yorkshire has continued the work connected with education and instruction in agricultural subjects, acting through the agricultural department of Leeds University, on the same lines as before. Full particulars are given of the council's scheme of scholarships and exhibitions. This provides assistance for persons desirous of obtaining instruction in all grades of education other than elementary. It provides for the properly qualified pupil in the elementary school who desires to proceed to a secondary school and furnishes him at a later stage with the means to enter a university; it also offers instruction to boys and girls who have commenced work in office or mill and can devote only their evenings to the continuance of their education, as well as to the craftsman who desires to increase his usefulness by further study. For the benefit of artisans and workers in the leading industries of the West Riding, such as the textile trades, engineering, coal mining, and agriculture, a number of technological scholarships and exhibitions have been set apart to enable the holders to go through specialised courses, usually of two years' duration. Technological scholarships were held in 1913–14 by five engineers and five textile workers.

BOOKS RECEIVED.

Chemical Engineering: Notes on Grinding, Sifting, Separating, and Transporting Solids. By J. W. Hinchley. Pp. viii+103. (London: J. and A. Churchill.) 2*s*. 6*d*. net.

A Manual of Dental Anatomy, Human and Comparative. By C. S. Tomes. Seventh edition, edited by Dr. H. W. M. Tims and Prof. A. Hopewell Smith. Pp. vi+616. (London: J. and A. Churchill.) 15*s*. net.

Functions of a Complex Variable. By Prof. J. Pierpont. Pp. xiv+583. (Boston and London: Ginn and Co.) 20*s*. net.

Text-book on Wireless Telegraphy. By Prof. R. Stanley. Pp. xi+344. (London: Longmans and Co.) 7*s*. 6*d*. net.

Methods of Quantitative Organic Analysis. By P. C. R. Kingscott and R. S. G. Knight. Pp. x+283. (London: Longmans and Co.) 6*s*. 6*d*. net.

Records of the Survey of India. Vol. iv. Explorations on the North-East Frontier during 1911–12–13, under the direction of Col. S. G. Burrard. Pp. 91. (Calcutta: Government Printing Office.) 6*s*.

Transactions of the Geological Society of South Africa. Vol. xvii. January–June. Pp. 59. 21*s*. Proceedings of the Geological Society of South Africa, to accompany vol. xvii. of the Transactions, January–June, 1914. Pp. xlix. (Johannesburg: *Transvaal Leader*.)

Mathematical Papers for Admission into the Royal Military Academy and the Royal Military College, July, 1914. Edited by R. M. Milne. Pp. 22. (London: Macmillan and Co., Ltd.) 1*s*. net.

The Journal of the Royal Anthropological Institute of Great Britain and Ireland. Vol. xliv. January to June. Pp. 240. (London: Royal Anthropological Institute.) 15*s*. net.

The Government-General of Formosa. Bureau of Communications. The Climate, Typhoons, and Earthquakes of the Island of Formosa (Taiwan). Pp. iii+80. (Taihoku: Meteorological Observatory.)

Soil Management. By the late Dr. H. F. King. Pp. ix+311. (New York: Orange Judd Company; London: Kegan Paul and Co., Ltd.) 1.50 dollars net.

Rural Improvement. By F. A. Waugh. Pp. xi+265. (New York: Orange Judd Company; London: Kegan Paul and Co., Ltd.) 1.25 dollars net.

Hunt and Burkett's Agriculture. Farm Animals. By Profs. T. F. Hunt and C. W. Burkett. Pp. ix+534. (New York: Orange Judd Company; London: Kegan Paul and Co., Ltd.) 1.50 dollars net.

The Manchester Municipal School of Technology. Calendar, 1914–15. (Manchester.)

Conferencias de Seismologia Pronunciadas en la Academia de Ciencias de la Habana. By M. G. Lanza. Pp. xvi+157. (Habana: Lloredo y Ca.)

Van Nostrand's Chemical Annual, 1913. Edited by Dr. J. C. Olsen. Pp. xiv+669. (London: Constable and Co., Ltd.) 12*s*. 6*d*. net.

Outlines of Applied Physics. By H. Stanley. Pp. viii+227. (London: Mills and Boon, Ltd.) 2*s*. 6*d*.

Department of Agriculture. Behar and Orissa. Crop Pest Handbook for Behar and Orissa (including also Western Bengal). Pp. xxiii+leaflets 84+appendices 21+plates liv. (Calcutta: Thacker, Spink and Co.) 4 rupees.

The National University of Ireland. Calendar for the Year 1914. Pp. clvi+476. (Dublin: National University.)

Leeds Astronomical Society. Journal and Transactions for the Year 1913. Pp. 106. (Leeds: R. Jackson and Son.) 2*s*.

DIARY OF SOCIETIES.

WEDNESDAY, OCTOBER 7.

ENTOMOLOGICAL SOCIETY, at 8.

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